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Annie Jump Cannon

By LEON CAMPBELL

Easter Sunday, April 13, 1941, marked the close of a long, happy, and successful astronomical career for Annie Jump Cannon, the world's most notable woman astronomer and a person beloved by all, both inside and outside the scientific realm. Born December 11, 1863, at Dover, Delaware, she had rounded out nearly four score years of which more than half had been devoted to her beloved science, astronomy.

She was born the daughter of Wilson Lee and Mary Jump Cannon, and, after obtaining those educational advantages which were available in her native city, she enrolled at Wellesley College in the class of 1884, taking what was then an almost unheard of step for young ladies of her age and set. At Wellesley she showed a deep interest in science—especially in physics and astronomy—and there she came under the immediate tutorship of Professor Sarah F. Whiting.

Upon the completion of her college work at Wellesley, Miss Cannon spent the greater part of the next ten years at her home in Dover. In 1894 she returned to Wellesley, to assist in physics; at that time she had an opportunity to aid in the X-ray experiments, a subject then in its infancy. In 1895 she enrolled as a special student in astronomy at Radcliffe, probably at the suggestion of Professor Edward C. Pickering, Director of Harvard Observatory, who had imbued her with the spirit of what women could do in astronomy. At Radcliffe, and also at Harvard Observatory, she gained much practical experience in observational technique, including transit circle work, time star observations, and, later, visual variable star observing. She was a pioneer among women astronomers in the field of variable stars, spending many a night over a span of more than a dozen years at the 6-inch telescope of Harvard Observatory.

Quick to realize the immense field of opportunity offered to women in the study and classification of stellar spectra from photographs, she joined the staff at Harvard in 1896 and from that time until illness prevented in March, 1941, it can truly be said that she devoted the best part of her life to her chosen field of research. The Henry Draper Catalogue is a living monument to her skill and painstaking care in the observation of the spectra, and the publication of the results. She had classified more stars than any other person, more than a third of a million. To her a spectral image was the open sesame to a star's secrets. Although Miss Cannon did little in the field of theoretical spectroscopy,

the scientific world will ever be indebted to her for the fundamental observational data which she accumulated over the years.

Not only was Miss Cannon an ardent variable star observer at the telescope but she was equally proficient in the discovery and observation of variables on the photographic plate. Her variable star discoveries numbered more than 300, and a large number of these variables were detected from their spectral characteristics. She has five nova discoveries to her credit, one of which she found while on a sojourn at the Harvard Observatory at Arequipa, Peru, in 1922.

Miss Cannon was a bibliographer of variable stars of the first rank Her card index of variable star information, numbering about a third of a million cards, is a further testimonial to her meticulous work in this field. The card index is, and has been for many years, a constant source of information to many of her colleagues at Harvard. From this card index she compiled her various variable star catalogues which for many years were the principal source of information for most variable star investigators.

Honors, well deserved and unique among women, have come to Miss Cannon. She was the first woman ever to receive the honorary degree of Doctor of Science from Oxford University, in 1925. She had previously received the degree of Doctor of Astronomy from Groningen, Holland, in 1921. Her alma mater conferred upon her the degree of LL.D. in 1925. Other degrees came to her from the University of Delaware, Oglethorpe University, and Mount Holyoke College. Doubtless the bestowal of these degrees was mainly in recognition of her scientific achievements, but it must be added that her personal charm certainly played an important part, for she made many friends, and having once made them she kept them. Miss Cannon was a real exponent of what women could do in astronomy.

She loved to travel and she visited Europe on many occasions. The first trip was made to observe an eclipse of the sun in Spain in 1892. She loved England and its people and, until two years ago, made almost annual trips there to renew old friendships and make new friends. As a prominent member of the International Astronomical Union, she attended all but the first of its meetings, wherever they were held, and at the meetings she was ever among devoted friends. Her friends were legion and she was loyal to her friends.

Miss Cannon was a member of many societies including the American Philosophical Society, the American Astronomical Society, of which she served as treasurer for a number of years, the International Astronomical Union, the American Association of Variable Star Observers, Phi Beta Kappa, Sigma Xi, an honorary member of the Royal Astronomical Society, and a member of the Bond Astronomical Club, of which she was vice-president at the time of her death. In 1931 she was awarded the Henry Draper Medal and in 1932 she received the final award of the Ellen Richards Research Prize, which, with characteristic gen-

erosity, she promptly turned over to the American Astronomical Society to establish the Annie Jump Cannon Prize for women astronomers.

In 1938 Miss Cannon was appointed William Cranch Bond Astronomer at Harvard, an appointment which she held until her official retirement in September, 1940. But retirement meant little in her life and she pursued the usual tenor of her work on the classification of the stars until stricken with her final illness.

Miss Cannon was a charming and delightful hostess, and few visiting astronomers, native or foreign, have failed to partake of her hospitality at "Star Cottage" in Cambridge. She was equally admired by all, the great and the small, the professional and the amateur alike.

The astronomical world will not soon forget Annie J. Cannon. She has left an indelible mark in the minds and hearts of all, and her achievements in her chosen field of research will stand as her perpetual monument.

It is given to few to enjoy life as greatly as did Miss Cannon. Hers was a life replete with satisfactions; hers can be called a truly happy life, well rounded. "Something attempted, something done, has earned a night's repose."

MAY 21, 1941, HARVARD COLLEGE OBSERVATORY,
CAMBRIDGE, MASSACHUSETTS.

Historical Background of the Cincinnati Observatory*

By ELLIOTT SMITH

ONE HUNDRED YEARS AGO

In 1840 O. M. Mitchel was giving lectures on astronomy in the Cincinnati College that led within three years to the founding of the Cincinnati Observatory. Since the one-hundredth anniversary is an occasion of considerable importance in the annals of an observatory, it is of interest to review the social, cultural, and business conditions in Cincinnati that enabled Mitchel to build an observatory and erect in it one of the world's largest telescopes at that time.

The rapid increase in the population of Cincinnati following the year 1800, reflects its growing importance as a pioneer city of the Southwest. The following table gives the figures for successive 10-year periods.

POPULATION OF CINCINNATI

Year	1800	1810	1820	1830	1840
Pop.	750	2840	10000	25000	47000

That a city should expand from a mere handful of pioneers struggling for the necessities of life at a great bend of the Ohio River into a com-

*Read at the meeting of the American Astronomical Society at Wellesley College, September 14, 1940.

mercial city of first importance all within 40 years is in itself an epic of the movement of people from the Atlantic seaboard westward.

Sources of Immigration

Settlers came first from New Jersey, followed closely by Pennsylvanians, Virginians, Marylanders, New Yorkers, and these by New Englanders. Pennsylvania and Virginia supplied the greatest number of native American residents. Of the foreign immigrants coming to Cincinnati, English and Scots were first in point of time, and Germans in point of numbers. Ireland and Wales also contributed a due proportion of immigrants. A great number of the people who settled in Cincinnati before 1810 came by way of flat-boats which were built at the headwaters of the Ohio and carried to their final landing-place by the current in the river. Here the rafts were dismembered and the lumber and timbers used in the erection of much needed shelter.

A Typical Migration

John Mitchel made the journey in this manner in 1804, five years before his son, Ormsby MacKnight Mitchel, was born. His experience is typical of thousands of others who added their numbers to increase the population of the Cincinnati region at this early period. John Mitchel was a man of standing and influence in Virginia, a surveyor by profession and well educated according to the standards of his day. On the land which he owned in Virginia he supported a large family of children, all growing up in comparative security in a well-established community. With the opening of the western region in the neighborhood of Cincinnati and throughout the West for settlement, land prices in the eastern states suffered a radical decline. Stories of the marvelous productivity of the soil in the new country made the stony, overcropped farm of John Mitchel seem meager and unproductive. Many a family conference was held with respect to disposing of their Virginia holdings and going to the new country, and no doubt a strong spirit of adventure was an incentive to the younger members of the family to decide in favor of the new undertaking.

In the fall of 1803 John Mitchel and one of his neighbors contracted for a flat-boat to be built at the town of Brownsville at the headwaters of the Ohio River and to be made ready for their use. Here the following spring, with the horses and wagons by which they and their household goods had been transported across the mountains from their Virginia home, the two families embarked for what they considered to be the land of promise. They landed in Kentucky a considerable distance down the river from Cincinnati, bought land, and established homes in the new country. But the Mitchel family were poorly prepared to endure the hardships and deprivations of a frontier settlement and to cope with the new conditions imposed. John Mitchel seemed never to have recovered from the belief that he had done his family a serious

injury in bringing them to the new country where they were deprived of the social and cultural advantages which they enjoyed in Virginia.

Education for Astronomy

Ormsby MacKnight Mitchel was but seven years of age when his father died leaving the family in very poor financial circumstances. The mother left the homestead, which she eventually lost through inability to meet the financial obligations, and went to live with a married daughter in Ohio whose husband was a minister and well educated. Although as a boy Ormsby endured deprivations due to the low finances of his mother he, nevertheless, received an education through the tutoring of older members of the family which put him far ahead of the grade he would have been in had he not had such assistance. As a consequence, when he attended school, he was invariably placed with much older pupils than himself.

At the age of 16 years, Ormsby entered the Military Academy at West Point. It was here that he received an introduction to practical astronomy as an inevitable part of the instruction in Civil Engineering given at the Academy. From this early introduction to the subject, Mitchel increased his knowledge of the science by private study to the extent that he was able to develop the system of lectures in the Cincinnati College and in public addresses that made him famous as an authority and lecturer on astronomical subjects.

Commerce and Culture

In 1840 Cincinnati may be said to have been at the crest of a prosperity due to steam-boat traffic on the Ohio and adjacent rivers and on its system of canals. The interior trade centering in Cincinnati spread over the whole extent of country between the Ohio River and the Great Lakes, north and south, and between the Scioto and Wabash Rivers, east and west. The Ohio River line of country in Kentucky for 50 miles down, and as far up as Virginia, made its purchases in Cincinnati. It was the distributing point for goods coming from foreign countries and its commercial relations extended to the upper and lower Mississippi states and territories. For manufactured goods these various regions returned sugar, cotton, rice, molasses, etc., from the south; lead, shot, furs, honey, etc., from Missouri and the upper Mississippi region; and pork, flour, etc., from Indiana.

This great steam-boat traffic and the unhampered movement of people up and down the river and in and out of the city and surrounding regions developed a romantic, care-free attitude toward life which became a part of the cultural background of Cincinnati. The determination of the people of the Cincinnati region to enjoy the passing show in which they themselves were the leading actors is reflected in the books: "Tom Sawyer," "Huckleberry Finn," and "Innocents Abroad" by Mark Twain, himself for many years a pilot on the system of big rivers. The

songs of Stephen Collins Foster, who may be said to have been native to the Cincinnati region, give expression of definite phases of the social life of the region and of its rapidly changing conditions. Among his familiar songs of the period may be mentioned: "O Susanna," "The Old Folks at Home," "Old Dog Tray," and "My Old Kentucky Home."

The epoch, 1840, witnessed many beginnings in Cincinnati which reflect the cultural state of the city at that period. Under "Fine Arts," we find *The Society for the Promotion of Useful Knowledge,* an association which originated in the desire to secure an extended education for its members by means of mutual instruction, and a wide sphere of usefulness by regular courses of popular lectures. The first meeting was held in March, 1840, and a constitution adopted. *The Eclectic Academy of Music* was organized in the spring of 1834 and received its charter from the Ohio Legislature in 1835. Its object was to promote knowledge and correct taste in music. *The Cincinnati Academy of Fine Arts* was formed in 1838 and its members held an exhibition of 150 pieces at the Mechanics Institute in 1839 which included both foreign and native works. *Lane Seminary* on Walnut Hills went into operation in 1833; the *Medical College* was chartered in 1825; and *The Ohio Mechanics Institute* opened its doors in 1828. It is eloquent of the substantial foundation of the social background of Cincinnati that nearly all of these activities have endured for 100 years and more and are being carried forward with continued enthusiasm in this year of 1940.

To Found an Observatory

Into this situation one hundred years ago, of a city in a receptive attitude toward new beginnings which should give emphasis to a cultural phase of its life, came Ormsby MacKnight Mitchel with a proposition to build and equip an astronomical observatory that should be as powerful as any in the world. In this enterprise he was inspired to disprove a statement which had recently been made by the Astronomer Royal of England to the effect that it was impossible to build and maintain an observatory in the United States. He said that there was no sentiment in the country for it and no source of funds for its support. President John Quincy Adams in 1825 recommended to Congress the founding of a National Observatory but much to his disappointment no action was taken in the matter.

To put his project into effect, Mitchel formed a "5-year" plan in which he resolved to devote every spare moment of his time to the founding of an observatory the equal of any in Europe. If the sentiment for such an enterprise were latent in the cultural life of Cincinnati and other large cities, Mitchel proposed first to bring it to a positive expression by a series of popular lectures on astronomy. He had already discovered that his lectures in the Cincinnati College were creating an unusual interest in the subject, as many persons aside from the students

of the College attended his classes. The enthusiasm with which his public lectures were received in Cincinnati and in Boston and New York shows clearly that Mitchel was an orator of surpassing ability. The inception and purpose of the lectures and the success with which they were carried out constitute an important contribution which Mitchel made to astronomy. His example in this direction has been the inspiration of builders of observatories in this country since his time.

Following a series of lectures on astronomy that delighted his audiences, Mitchel organized the Cincinnati Astronomical Society in 1842 to carry out the second part of his "5-year" plan, that of building an observatory and equipping it with a powerful telescope. The success of this enterprise is recorded in the inscription on the corner stone of the observatory which states that it was laid by John Quincy Adams Nov. 9, 1843. The ex-president, then in his 77th year, still maintained an active interest in the matter of establishing an observatory in the United States. He made the arduous journey from Boston to Cincinnati to take part in the ceremony. The city recognized the honor of his coming by passing an ordinance naming the promontory on which the observatory was built, Mt. Adams, and the name still applies to this section of the city.

Constitution and Charter

Of the historical documents in the library of the Cincinnati Observatory none are of greater historical interest than the Constitution and the Charter of the Cincinnati Astronomical Society under the date of May 1, 1842. In our time the preamble to a document is of brief consideration; we proceed at once to the business in hand; but 100 years ago it seemed important for an organization to justify its existence in an eloquent statement of its purposes. Such is the preamble to this Constitution which I quote as follows:

Preamble

> Believing it to be the duty of every people to foster science, and to add, as far as possible to the general stock of human knowledge; recognising to the fullest extent, the claims which the world has on the several republics composing the United States, to contribute to the promotion of science, in proportion to their natural, social, and constitutional advantages; realizing the truth, that in our own country, and under a republican form of government, the people must hold, with respect to all great scientific enterprises, that position of patrons, which in monarchial governments is held by Kings and Emperors; and knowing that our country is comparatively deficient in means and instruments to accomplish original observations in Astronomy; Therefore, for the purpose of furnishing our city with an Observatory and Astronomical Instruments, in all respects adequate to the wants of science, we, the undersigned, have united and agree to contribute the sums already subscribed,

CHARTER MEMBERS OF THE CINCINNATI

H. J. Adams
D. H. Allen
S. O. Almy
Dan Ames
Paul Anderson
John G. Anthony
J. S. Armstrong
John C. Avery
O. P. Aydelotte
Ezra Bailey
John Baker
Geo. H. Bates
Jos. S. Bates
Lyman Beecher
J. P. Beggs
Thos. J. Biggs
G. G. Bowen
R. R. Bowler
B. Boylan
Julius Brace
R. C. Brasher
W. G. Breese
Tunis Brewer
A. L. Brigham
J. P. Braodwell
J. T. Brooke
E. S. Brooks
M. Brooks
Isaac C. Burnet
J. Burnet
R. W. Burnet
J. A. P. Burrows
D. K. Cady
Jas. Calhoun
Geo. Carlisle
Lewis Carneal
Calvin Carpenter
Thos. Carroll
Wm. Carson
D. E. Cassat
S. P. Chase
F. A. Churchill
Jonathan Cilley
Sam'l Cloon
Horace Cole
Wm. H. Comstock
Charles Duffield
J. Duncan
Dan Drake
Richard Eberle
J. M. Edwards
J. A. Ellet
Rowland Ellis
W. Ernst
D. K. Este
A. H. Ewing
S. Fales
Osgood Fifield
Sam'l B. Findley
Charles Fisher
M. Flagg
John P. Foote
J. C. Conover
Jesse W. Cooke
R. F. Cooke
Isaac C. Coplen
J. R. Coran
H. Crane
T. Crane
Jos. H. Cromwell
Wm. Crossman
J. C. Culbertson
A. Curtis
Tyler Davidson
H. F. Davis
Wm. Dennison
Edmond Dexter
Sam'l E. Foote
Sam'l Fosdick
H. Ford
James Foster
Charles Fox
J. Frazer
M. French
E. Gaither
S. B. Garrard
John W. Garrison
Joseph Gest
Peter Gibson
Jas. S. Glascoe
S. H. Goodin
Henry H. Goodman
Wm. Goodman
James Gorman
Geo. Graham
Wm. Green
Miles Greenwood
Walter Gregory
David Griffey
D. Griffin
H. Groesbeck
J. H. Groesbeck
W. S. Groesbeck
Walter Guilford
Harvey Hall
G. R. Hand
L. Harding
Anthony Harkness
Wm. Harkness
Geo. W. Harlan
John P. Harrison
Sam'l M. Hart
Burton Hazen
Joseph Herron
Geo. H. Hill
Philip Hinkle
R. Hodges
A. P. Holden
S. Holmes
Lewis Hunt
Rukard Hurd
A. Irwin
James F. Irwin
Chas. P. James
J. A. James
U. P. James
C. Jeffers
Thos. H. Johnson
J. Jones
J. H. Jones
Jno. H. Jones
Talbot Jones
Wm. Judkins
John Justis
R. W. Keys
John Kilgour
Jno. W. King
T. Kirby

ASTRONOMICAL SOCIETY, 1842

Elam P. Langdon
David B. Lawler
E. Lawrence
B. S. Lawson
R. W. Lee
R. J. Levering
Albert Lewis
S. S. L'Hommedieu
R. F. L'Hommedieu
N. Longworth
A. McAlpin
Jas. McCandless
Wm. McCammon
H. McDougal
M. C. McLean
Wm. Manser
E. D. Mansfield
Elbert Marsh
V. C. Marshall
T. B. Mason
Thos. L. Mathews
Wm. Medary
C. Merrill
A. Miles
E. J. Miller
Thos. H. Minor
O. M. Mitchel
A. M. Mitchell
Ephriam Morgan
Sam'l Morrison
Phineas Moses
Jno. Mullen
S. B. Munson
R. D. Mussey
Geo. W. Neff
William Neff
R. E. Niel
Thomas Newell
John Noble
Wm. Oliver
S. C. Parkhurst
N. G. Pendleton
J. H. Perkins
Geo. W. Phillips
R. C. Phillips
J. W. Piat
Henry Pierce
James Pierce
E. Poor
D. A. Powell
A. Pugh
James Pullan
J. B. Purcell
Jos. Ray
H. L. Reeder
Geo. Reeves
Wm. Resor
Jabez Reynolds
J. P. Reynolds
Wm. Ridgley
L. C. Rives
E. R. Rosa
P. Rogers
Luther Rose
Wm. H. Ross
Chas. Satterly
G. R. Schoenberg
Chas. Schultz
R. S. Scudder
D. H. Shaffer
L. H. Shalley
H. O. Sheldon
John Shillito
Jno. Shotwell
Hiram Sloop
S. S. Smith
Jos. Smith
Peter Smith
James Southgate
C. G. Springer
R. R. Springer
Henry Starr
Benj. Sterrett
C. Stetson
Alex. Stewart
B. Storer
C. E. Stowe
Jacob Strader
Thos. J. Strait
J. B. Summons
John H. Swan
A. M. Taylor
Griffin Taylor
W. H. H. Taylor
John L. Talbot
J. D. Thorpe
Wm. Threlkild
Geo. P. Torrence
A. Valentine
Martin Van Buren
H. P. Vancleve
J. L. Van Doren
Wm. J. Van Horne
J. L. Vatter
J. C. Vaughn
Joseph Wade
J. W. Wade
M. S. Wade
E. Q. S. Waldron
J. A. Warder
Henry Ware
C. G. Wayne
Geo. L. Weed
John Whetstone
B. D. Whiteman
Louis Whiteman
Sam'l Wiggins
Clark Williams
E. S. Williams
M. G. Williams
M. T. Williams
W. R. Williamson
Wm. Wiswell
Geo. Wood
Henry Wood
W. Wood
Wm. Wood
John Westcott
Charles Woodward
V. Worthington
M. B. Wright
N. Wright
Griffeth Yeatman
Thos. H. Yeatman
A. Young
Isaac Young

and for our mutual guidance and government, do adopt the following constitution.

Attached to the constitution are the names of the 274 charter members of the society, and perhaps no group of Cincinnatians is more representative of the substantial cultural background of the city 100 years ago. Since many of them, or the descendants of many, will be recognized as having attained distinction in the city, state, or nation in the 100 years intervening, I give the entire list (see pages 352, 353).

It would be a task beyond the scope of this discussion to point out in detail the contributions of members of this group to the welfare of the city and nation. Those who read the list will recognize the name of a President of the United States, a Secretary in the Cabinet of President Lincoln, and possibly Judges and Congressmen of this early period, 100 years ago.

A consideration of descendants of the group is of particular interest. For example, Harriet Beecher Stowe, daughter of a Charter Member, wrote, "Uncle Tom's Cabin," in a modest home about a mile north of the Observatory at Mt. Adams. The name, N. Longworth, prominent in the Charter, has been maintained in public life through succeeding generations. John Kilgour, Jr., the son of the John Kilgour, Sr., whose name appears in the Charter, gave the land and a substantial sum of money toward the erection of the Cincinnati Observatory at its present site in Mt. Lookout, six miles farther out from the business section of the city than its location at Mt. Adams. At the present time there are ten direct descendants of John Kilgour, Jr., living in Cincinnati. Of the Charter Members as a whole, it may be said that they are still substantially represented in Cincinnati by descendants to the fourth and fifth generation.

It will be well to bear in mind that in celebrating the one-hundredth anniversary of the founding of the Observatory we also celebrate the seventieth anniversary of its reestablishment at its present site thirty years later through the benefaction of John Kilgour, Jr. The inscription on the front of the Observatory at Mt. Lookout bears the year of its erection, 1873, while the corner stone carries the date thirty years earlier. An added inscription states that the corner stone was removed from the Observatory at Mt. Adams and relaid in the wall of the new Observatory in the year of its building, 1873.

O. M. Mitchel occupies a unique position in the science of Astronomy because of the pioneer work which he did in a situation where prior to his time there was only opposition. He concentrated on the task of bringing out the universal inclination people have of knowing about the relation of the earth to other celestial bodies. The eager response which they gave to his representations shows that Mitchel was an orator of surpassing ability.

There is always an inclination to speculate upon the conditions that

produce great orators. In this connection it is of interest to note that in the region south of Cincinnati from which came the inspiration for, "My Old Kentucky Home," two native sons, Ormsby MacKnight Mitchel and Abraham Lincoln, were born within four months of each other in 1809 and brought up under the rigors of its pioneer life. In 1840 while Mitchel was carrying out his 5-year plan to show that an appreciation of the value of astronomy actually existed in the new nation and to build an observatory, Abraham Lincoln in necessary trips to New Orleans was gaining a first hand knowledge of the effects of slavery on our national life. Lincoln dedicated his life to the elimination of slavery from the nation and in this task became the outstanding orator of his day. In the war that followed 20 years later these two native sons of Kentucky eventually gave "the last full measure of devotion" to the nation which each in his own way ardently represented.

CINCINNATI, OHIO.

Southern Observations of the Zodiacal Light

By ALICE H. FARNSWORTH

A trip to the southern hemisphere is a salutary experience in changing provincial attitudes of mind such as the exclusive association of apple-blossoms with May and of snow and ice with the sun's entry into Capricornus, or an insistence that the Man-in-the-Moon be right side up at meridian passage and that well-behaved circumpolar constellations go counter-clockwise in their diurnal travels.

Heretofore my main concern with the Zodiacal Light has lain in attempting to show it to students late in February when the ecliptic as seen from mid-northern latitudes rises almost perpendicularly from the western horizon in the early evening. It is a favorable season to step out on the west porch of the Observatory as soon as twilight is safely over, and suggest: "Do you see the Milky Way yonder in the northwest, stretching up from the horizon into Cassiopeia, and on up through Perseus, the Double Cluster standing out clearly? Note that the background of faint stars is not smoothly luminous but rather patchy and irregular in texture and form. Now if you will gradually move your eyes to the left along a circle parallel to the horizon you will soon lose the galactic concentration and notice that you are now seeing stars upon a relatively black background instead. Look for instance at the chain $\alpha\beta\gamma$ Andromedae leading up from the Great Square in Pegasus. This region of blackness, however, is not very wide, for soon, still looking more and more nearly straight westward you find the stars again seemingly projected upon a luminous mist, smooth and uniform in character. Having convinced yourself of the reality of this misty veil, you

will probably be able to detect its shape, tapering from a relatively broad base near the horizon across the ribbons of Pisces, past the arc of Aries, to an apex marked approximately by the Pleiades."

To detach the zodiacal light from this familiar position and to break its close, usual association with these particular constellations (compare also Trouvelot's well-known drawing) was one of the privileges of my recent trip to South America. The light was noted on several occasions from the south-going freighter and was beautifully seen "extending well up into Libra" on the night of September 3 when we lay outside Recife, Brazil (8° south of the equator). From Curema, our eclipse site 250 miles northwest of Recife, evening observations in late September found Zodiacal Light and Galaxy both in the southwest, merging and becoming indistinguishable at a rather low altitude in the Lupus-Scorpio region.

The observations listed herewith were made in the latter part of 1940 from Bosque Alegre (Long. 64° 33′ W; Lat. 31° 36′ S; elevation 4000 feet) where the National Observatory of Cordoba, Argentina, maintains a mountain station. The numerical data in the table are supplemented by notes and drawings. Greater preparedness could have led to more detailed, accurate, and useful information. The original records were in the form of written notes with a few fragmentary sketches, reduced to order after an interval of some months. The observations were purposely made without paying any heed to the course of the ecliptic. It has seemed best to include all observations without regard to apparent consistency.

No.	Date 1940	Time of Obs'n	Time of Twi	Interval		Apex Long.	Apex Elong.	Apex Dev.	Pos'n of Ecliptic in Cone
1	Nov. 26	21^h45^m	21^h42^m	1^h40^m	after	330°	E 85°	2°S	Close to N edge
2	Nov. 30	21 50	21 46	1 42	after	323	E 74	3 S	Nearer N edge
3	Dec. 1	4 10	4 28	1 56	before	144	W105	3 S	Nearer N edge
4	Dec. 24	22 00	22 03	1 36	after	338	E 65	6 S	Near N edge
5	Dec. 26	22 15±	22 05	1 50±	after	358	E 83	4 S	Nearer N edge
6	Dec. 28	4 50	4 32	1 24	before	207	W 69	15 S	Cuts N edge at large angle
7	Dec. 29	22 05	22 06	1 39	after	(40	E122	?)	Near N edge
8	Dec. 30	22 10	22 06	1 44	after	(65	E146	17 S)	Near N edge
9	Dec. 31	4 20	4 35	1 55	before	187	W 92	3 S	Nearer N edge
						(137	W142	8 S)	

NOTES

No. 1. Z.L. seems slim; much brighter than Milky Way, as bright as Magellantic Clouds high in the south. Clear, uniform sky. Fusing in Ara, Sco, and Sgr, Milky Way and Z.L. make an obtuse angle with each other, like a great pair of wings tipped slightly southward at western horizon. Still visible an hour later. See Figure 1.

No. 2. Z.L. very conspicuous, more so than Magellanic Clouds; Milky Way hard to see. Sky uniform but not very transparent. Z.L. about as described on November 26, except that it could not be traced beyond δ Capricorni. At intersection of "wings" lie θ Arae and ζαε Telescopii. Not shown in drawings.

No. 3. No record of brightness. My impression is that morning observations seemed always more difficult and less certain than those made in the eve-

ning. Spica central. Night has remained clear throughout. Z. L. joins Milky Way in Lupus-Centaurus region.

No. 4. Christmas Eve. Z.L. difficult; reaches low altitude at τ Aquarii. High wind. Sky murky, following marvelous sunset effects. Not shown in drawings.

No. 5. Z. L. could be traced farther than on December 24, though observed after a heavy fog which returned later. Lightning in southwest. See Figure 1.

No. 6. Sky not uniform, lightning in low cloud, obscuration in zenith. Z.L. with Mars central makes acute angle with Milky Way at Antares. Original observation is a sketch, included in Figure 3.

No. 7. In intensity Z.L. like Lesser Cloud or horizon portion of Galaxy (near TrA). Not a brilliant night but seems uniform in the west. Record impression of a continuing band instead of an apex. Bright planets interfere (see note under No. 8). Appearance is that of No. 8 in Figure 2, except that band was traced to a greater elongation on the second night.

No. 8. Excellent sky. Same general appearance as on December 30. "Jupiter and Saturn seem to make a dark hole around themselves so that α Piscium and northern part of Cetus pentagon seem to be out, but after the jog caused by the planets, one gets the impression of possibly a continuing band kept out of Eridanus's big loop by $\delta\varepsilon\zeta\eta$, moving on toward Orion's lion's skin." See Figure 2.

No. 9. Light has same quality as that of Milky Way (in Cen and Cru). The two together form a striking picture. Night has remained quiet and uniform. See Figure 3. Apex, if any, is as indicated but a band could be imagined continuing past ρ and α Leonis, bumping into Hydra's head.

Times are recorded in Argentina legal time (3^h west of Greenwich) adopted for use in all parts of the country throughout the year; for Bosque Alegre it is in the nature of a perpetual daylight-saving schedule. For the six evening observations, times of the end of evening twilight and the interval between sunset and the time of observation are recorded; for the three morning phenomena the beginning of morning twilight and the interval before sunrise. For the estimated apex are given its longitude, its elongation to east or west of the sun, and its approximate departure from the ecliptic to north or south. Where no apex was observed the figures (in parentheses) apply to the region where the band was lost sight of. The position of the ecliptic with respect to the light-cone as a whole is given in the last column.

In Figures 1, 2, and 3 stars that are labelled were recorded as points of reference in defining boundaries of the light. To show orientation with respect to the horizon, Figures 1 and 2 should be tipped about 30° to the right, Figure 3 to the left. Figure 4 gives the position of the sun in the ecliptic on two dates separated by about a month, together with the extent of the corresponding morning and evening light. It shows how the double cone with the sun at its center seems to move along the ecliptic in response to the earth's motion along its orbit. Within thirty-five days, the Zodiacal Light is seen to cover four-fifths of the ecliptic in longitude. The observations are of unequal weight on account of variation in seeing. The anomalous appearance of the cone on December 28 (No. 6) may perhaps be attributed to partial obscuration, the narrowing of the base on December 31 (No. 9) possibly to the proximity of the Galaxy. The presence of bright stars or rich fields

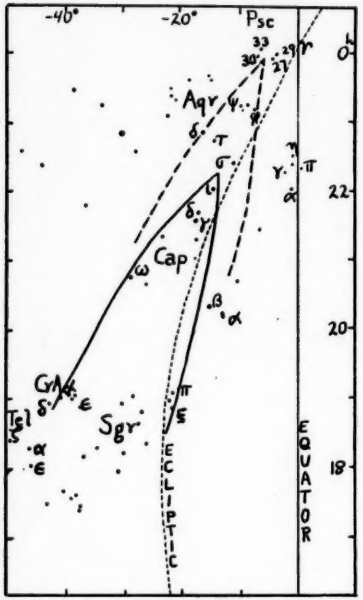

FIGURE 1

Evening Zodiacal Light, observations a month apart. Full line: No. 1, Nov. 26; dash line: No. 5, Dec. 26, 1940.

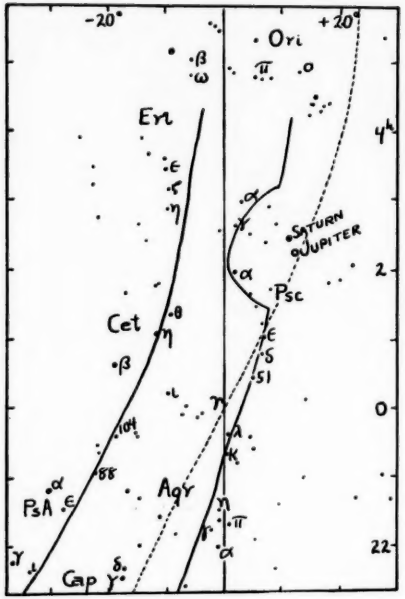

FIGURE 2

Evening Zodiacal Light, observed with band. No. 8, Dec. 30, 1940.

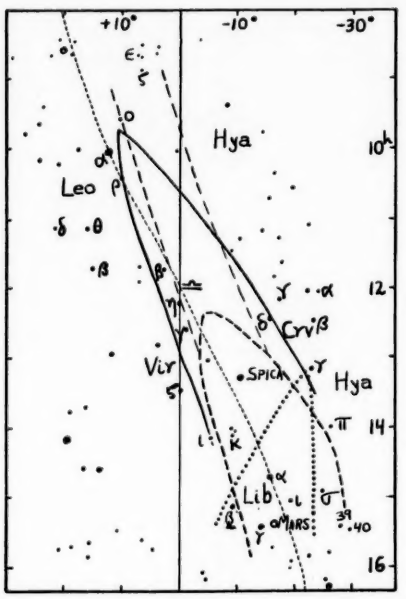

FIGURE 3

Morning Zodiacal Light. Full line: No. 3, Dec. 1; dotted line: No. 6, Dec. 28; dash line: No. 9, Dec. 31, 1940.

must certainly affect estimates of the form, position, and extent of the excessively faint band recorded as extending to elongations of more than 140° both east and west. The widths recorded in the drawings are not certain enough to bear close scrutiny. The consistent displacement of the cone of light southward from a position of symmetry with respect to the ecliptic is conspicuous and evidently real, since the observtions are unanimous in showing it.

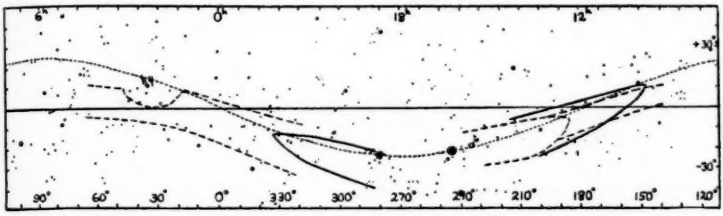

FIGURE 4

The full lines show the Zodiacal Light as observed on the evening of Nov. 26 (No. 1) and the morning of Dec. 1 (No. 3); the position of the sun (long. 247°) on the mean of these dates is indicated by ☉. The dash lines represent observations made a month later on the evening of Dec. 30 (No. 8) and the following morning (No. 9); the place of the sun (long. 279°) is marked by *. In these cases, extension of the cone into a band was noted. Symbols of the planets indicate their position at the end of December.

My last view of the Zodiacal Light from Bosque Alegre came at the end of my last night of observing on the mountain. The spectacle in the southeastern sky just before dawn twilight began was glorious and long to be remembered. The Zodiacal Light to the east with the Galaxy to the south formed a great continuous luminous pathway in the form of a loop, outlined by a jeweled circle of vari-colored objects from Spica through α Librae and Mars to the stars of Scorpio in array from δ to ζ. Another less complete festoon of stars paralleled the first a few degrees below it; the rich fields of Lupus and Centaurus sparkled from the dark space enclosed by the loop. Shining higher up in the south were the Pointers and the Southern Cross. As the east began to glow, ruddy Venus quietly joined the picture at the base of the curve, in orderly position in the second rank.

MOUNT HOLYOKE COLLEGE, SOUTH HADLEY, MASS., MAY 10, 1941

Our Sun is Bound to Explode

By GEORGE GAMOW
Professor at the George Washington University

As the chemical reactions proceed in its interior, our sun is becoming hotter and hotter. And, at a certain point of its evolution, a terrific explosion will take place.

Although the picture of the stellar sky with its invariable constellations can be considered by a casual observer as a perfect example of permanency, the stars are actually living their own and sometimes very turbulent lives. Undoubtedly, the most colorful events in the evolutionary lives of stars consist in vast stellar explosions which cause previously inconspicuous stars to turn overnight into the most brilliant objects in the sky. Such terrific increases of stellar luminosities are, however, only temporary phenomena, and, often after passing through maximum, exploded stars fade very rapidly, returning to normal brightness a year or two after the outburst.

The most classic example of such stellar catastrophes is furnished, of course, by the famous "Star of Bethlehem" which flared up in the year 4 B.C., and became so important in the history of religion. Unfortunately, the Hebrew shepherds, who claim to have observed this star, did not care to leave to posterity its exact position in the sky, and thus deprived us of any possibility of looking for the remnants of that memorable explosion. Considerably more is known about another similar explosion, that of the year A.D. 1054, since the Chinese astronomical manuscripts of the eleventh century give the exact position on the celestial sphere where this explosion was seen. Looking now at that place, we find a very peculiar nebulosity formed by the masses of rapidly expanding luminous gas, and known in literature as the "Crab Nebula."

There seems to be hardly any doubt that these gases were expelled by the terrific stellar explosion observed by the Chinese 877 years ago, and careful telescopic observations reveal in the very center of the gas cloud a faint star which evidently represents the remainder of the explosion.

The latest of the stellar explosions, visible to the naked eye even in the broad daylight, was registered in the year A.D. 1572 by the Danish astronomer Tycho Brahe. Although Tycho was sufficiently careful to give the location of the exploded star, we are as yet unable to tell which one of the several faint stars seen near that point actually represents the result of that stellar catastrophe.

One should not, however, conclude from the comparatively small number of historically registered stellar explosions that these phenomena are very rare. In fact, before the construction of the telescope and

the beginning of the systematic photographic survey of the sky, only the most brilliant "new stars" could have been noticed. In addition to these exceptional cases, which are now classed as "super-novae," there is also a much larger number of comparatively fainter "ordinary novae" which are usually recorded by telescopic observations and appear at the rate of about twenty each year.

It seems at present very probable that the difference between super-explosions (corresponding to a billion-fold increase of luminosity) and ordinary explosions (when the luminosity increases only by a factor of several hundred thousand) lies entirely in the original mass of the exploding star, so that the comparative rarity of supernovae must be explained as due to a small number of very massive stars. Thus, whereas the explosion of such a giant star as Sirius would lead to a very brilliant supernova comparable with the "star of Bethlehem," *the explosion of our own sun, which is known to be a middle weight star, would be probably classed as an ordinary common nova.* This will make, however, but a very little difference for the population of the earth, since in both cases *the increase of solar heat will be quite sufficient to turn our planet instantaneously into a cloud of hot gas!*

But is our sun going to explode, and, if so, when?

We can make the first approach to the solution of that vital problem by the methods of ordinary statistics. It is known, in fact, that our stellar system or Milky Way, of which our sun represents but one humble member, is about two billion years old. If we assume, as a plausible hypothesis, that the present rate of stellar explosions is characteristic for the entire life-span of the stellar universe, we must conclude that about forty billion stars must have already exploded in the past. Since, on the other hand, the total number of stars forming the Milky Way can be estimated as between forty and eighty billions, we see that *the chances of explosion for any individual star are fairly high.*

However, such statistical considerations cannot permit us to tell whether our sun is on the list of the next twenty stars due to explode in A.D. 1942, or whether it has still a few billion years to live. In order to be able to answer our question more exactly, and if possible to predict the year of solar explosion, we must learn a little more about the evolutionary life of the sun, and, in particular, about the energy sources which are supporting its daily radiation of light and heat.

The problem of the origin of solar energy has always represented one of the most exciting, but also one of the most mysterious questions of science, and its complete solution became possible only during the last few years. It is now established beyond any doubt, that *the energy supply of our sun, as well as that of all other stars in the sky, is due to the process of transformation of elements, that is to the very same process which was so unsuccessfully looked for by the medieval alchemists.* The reader might know in fact, that, after the inglorious collapse of the medieval attempts to find the "philosopher's stone" which

would turn common metals into gold, and, in addition give eternal youth, a "New Alchemy" arose again at the beginning of the present century. This new era in the science of matter is inseparably connected with the names of the French physicists Becquered and Mme. Curie, the discoverers of radioactivity. It was shown by them, in fact, that the atoms of certain heavy elements, as uranium, thorium or radium, are unstable and are breaking into smaller pieces with the liberation of a vast amount of so-called "subatomic energy." This fundamental discovery was followed in 1919 by the epoch-making experiments of the famous British physicist Lord Rutherford, who succeeded in breaking up the atoms of usually stable common elements, such as nitrogen or aluminium, by bombarding them with the fast moving atomic projectiles. In his pioneering work on the atomic bombardment, Rutherford was using fast particles ejected at high speed from the decaying atoms of the naturally radioactive elements, but the further progress of experimental technique made such arrangement quite unnecessary. At the present time, a great many of the physics laboratories throughout the world possess very complicated, and often very massive, machines known as "atom-smashers," which artificially produce powerful beams of atomic projectiles for all kinds of work in modern alchemy.

It must be indicated here, however, that although the present development of physics completely confirms the expectations of medieval alchemists concerning the possibility of artificial transformation of one chemical element into another, such transformations can be carried out at present only on an extremely small scale. Thus, whereas the physicist of today knows exactly how to make atoms of gold from, let us say, the atoms of mercury, the amount of gold that he can produce is so negligibly small that only the most sensitive analytic methods can prove its presence.

But the great difference between the medieval alchemists and the scientists of today lies in the fact that it is not gold, or any other precious metal, we are now after. In fact the study of natural and artificial transformations of chemical elements reveals a striking fact that the amounts of subatomic energy liberated in atomic decay are so large that their dollar value exceeds by a factor of several thousand the value of gold which can be produced in the process. Thus, if through the further progress of science and technics, we will sometime be able to open broadly the faucets of the subatomic energy reservoirs, it will be used not for making gold coins, but rather for flying aeroplanes across the Atlantic on a pint of fuel, or (taking into account the bad taste of humanity) for demolishing large cities by a couple of average sized bombs. If occasionally gold will be produced in one of such alchemic reactions, the gold-dust thrown out from the exhaust valves of subatomic motors will be no more valuable than the smoke from today's steam engines!

Returning to our main problem of the life of the sun, we must state that, whereas the technical utilization of subatomic energy under terrestial

conditions represents at present almost insurmountable difficulties, these alchemic processes are going on in the hot interior of the sun almost as easily as the ordinary chemical reactions are going on in our laboratories. It was shown in fact by Atkinson and Houtermans about twelve years ago, that *at the temperature of 20,000,000 degrees centigrade characterizing the interior regions of the sun, the liberation of subatomic energy is going on sufficiently fast to provide for all the light and heat emitted by that giant body into the surrounding space.* They have also suggested, that the particular alchemic reaction responsible for solar heat consists in the transformation of the familiar gas hydrogen (forming 11 percent of ordinary water) into the solar gas helium. At that time the subatomic physics was not yet sufficiently developed so as to to give all details of the process, and it was only in 1939 that the complete study of it was made by Bethe. It was, in fact, shown by Bethe that the transformation of hydrogen into helium is greatly helped by the presence of a small amount of carbon and nitrogen, and that, *assuming the observed concentration of these elements in solar matter, one comes to the value of subatomic energy liberation exactly coinciding with the observed radiation of the sun.* Applying similar consideration to others stars, one also obtains a remarkable agreement with their observed luminosities.

But, if hydrogen represents the main fuel of the stellar world, and is being continuously transformed into the inactive helium in a way very similar to the burning of ordinary coal into carbon dioxide, all stages of stellar evolution must be essentially determined by the amount of this "alchemic hydrogen fuel" available.

It would seem at first sight that, with the decreasing amount of the available hydrogen fuel, the sun must steadily cool down and that the amount of light and heat received by the earth is bound to decrease from year to year. It was, however, shown by Gamow that the situation is exactly opposite, and that the *radiation of the sun is actually slowly increasing.* This results from the fact that the decreasing amount of hydrogen, causes the central temperature of the sun to rise, so that "alchemic burning" of the remaining "hydrogen fuel" is proceeding more and more violently. The less hydrogen that is left in the body of the sun, the larger will be its radiation, and *when the solar hydrogen content drops from its present value of 35 percent down to only 1 percent the sun will become about one hundred times as bright as it is now.*

It is easy to see that under the burning rays of the sun of the future, our earth will become a rather uncomfortable place to live. The rocks on the dayside of the earth will become as hot as the kitchen stove, and the waters of the oceans will begin to boil enveloping the earth with the thick layer of heavy clouds. During the night conditions will probably be somewhat milder, but few stars will be seen through the occasional openings between the clouds resulting from the day's heat. If intelligent human beings are still present on the earth in this distant future, they will

have to spend most of their time in airconditioned underground shelters, and will be able to come out only in the night when the heat will be less destructive. But it is, of course, very probable that by that time the progress of science will permit humanity to migrate to some more distant planet on which the heat of the sun will not be so terrific, and to start a new culture on Saturn or on the far distant Neptune.

Fortunately enough, the above described picture corresponds to a very distant future indeed, since the consumption of hydrogen and the increase of solar brightness are going on extremely slowly. It has been estimated, in fact, that the chemical reaction producing the radiation of the sun consumes about 0.000000001 percent of solar hydrogen per century, so that *it will be several billion years before this amount will be essentially changed, and the sun will become hot enough to set the oceans boiling!*

Having removed the immediate danger arising from the steady evolutionary increase of solar brightness, we still have to deal with the possibility of a sudden explosion which, as we have seen, hangs as a Damocles sword over the life of every star. But also here, the present theory of stellar evolution strikes a quieting note, for the immediate future of humanity at least. In fact, the reaction of "alchemic burning" of hydrogen, which is supplying at present the solar radiation, turns out to be *an extremely well balanced process,* and there does not seem to be any possibility of anything going wrong and causing an explosion or catastrophe.

On the other hand, the theory indicates that *the stars which are much older than the sun, and have already completely consumed their "alchemic fuel" stand before the immediate danger of a catastrophic collapse.* According to the recent theory of such collapses, proposed by Gamow and Schoenberg, this is mainly due to the fact that in the later stages of their evolution, the stars begin to produce in their interior a large number of a new kind of subatomic particles known in the physical literature as "neutrinos." These "neutrinos," which can be justly described as the "bacteria of subatomic world," are so small that they can penetrate without any difficulty through any thickness of material and the experimental physics of today, being not able to catch them directly, draws conclusions about their existence only on the basis of complicated indirect evidence. When these "subatomic bacteria" begin to be produced in large quantities in the central regions of the ageing star, they pass through the outer layers of the stellar body and escape into the interstellar space carrying with them large amounts of internal heat. *Being cooled from inside through the unceasing losses of "neutrinos," the star cannot support anymore its own weight, and collapses inwards with a brilliant display of fireworks.*

If the above described theory is correct, and there seem to be all indications that it is, *the phenomena of nova and supernova explosions should be considered as the last violent outbursts of stellar activity im-*

mediately preceding the thermal death. Since our sun is still very young, and has an abundance of "alchemic fuel," it stands in no immediate danger of any collapse of such kind, and we can say with a degree of certainty *that the catastrophe which will turn our earth into a cloud of hot gas is removed from us by at least several billion years.*

The Role of the Amateur in Variable Star Astronomy*

By LEON CAMPBELL

For the past few weeks listeners over Station WRUL have been hearing a great deal about the stars; about their physical properties, both interior and exterior; about binary systems; and, more recently, about variable stars in particular.

By now you know, if you didn't know before, that variable stars are those which change their brightness from time to time. You have heard about those variables which go through their light changes in a few hours, as regularly as clock work—in fact more regularly than most clocks or watches—while others require days and weeks to repeat their cycles of variation; yes, even years!

Perhaps you have also gained the impression that variable stars, though all right in their way, are the sole responsibility of the professional astronomers who will continue to observe the stars' variations, deduce new facts and laws governing their actions and then, later on, tell the listening world more about them.

While it is true that the trained astronomers will tell us of the new facts learned concerning *why* the stars vary, yet it is to the amateur that the professionals must look to find out *how* they vary. And this is not a too difficult task to impose on the amateur astronomer. In fact he has been doing this very sort of thing for many years past, especially since the turn of the last century. He has been on the alert at his telescope keeping tabs on many variable stars, recording their brightness at stated times, accumulating an historical record of what they have been doing from night to night and month to month. His work has become of so much importance to the professional astronomer that the constant vigil on the brighter stars has been relegated, by a sort of unspoken understanding, to the amateur.

For those people living in a particular hemisphere—whether northern or southern—the self-same stars shine over them all, not at the same hours to be sure, but over a stretch of twenty-four hours. If Orion blazes

*Broadcast from station WRUL, in the series of Harvard radio talks, on March 8, 1941. For other talks in this series, see POPULAR ASTRONOMY for April, 1941, p. 191, May, 1941, p. 236, and June, 1941, p. 311.

forth in the sky of New England at 6:00 o'clock tonight we know that it was similarly observable in Old England five or six hours earlier, and will be seen again on the Pacific Coast some three or four hours later. When folks in Boston and Chicago are observing Sirius—the Dog Star—they can be sure that the Asiatics will be seeing it a half day later. The daily rotation of Mother Earth upon her axis brings to each and every one, in turn, the self-same stars and constellations, in their respective hemispheres.

But to get back to the story of the amateur astronomer and the part he plays in variable star observing; and he plays an important part therein!

By amateur astronomer we mean one who makes astronomy his hobby, or avocation, rather than his vocation. He it is who observes the stars for the love and the thrill of the thing; and he surely finds plenty of thrills, whether in snow-covered yards in a New England city, the wide expanses of our Middle-West, or in the more salubrious climates of Italy and India. He it is who drags out his telescope each clear evening to see "what's up" in variable star activities, and to note if a particular star had faded considerably in light since the last time he looked, or if another star has suddenly increased in brightness since last night. Or perhaps this particular amateur, variable star observer has had erected in a shelter atop his home, or in his back yard, a more pretentious telescope, fitted with setting circles and electric clock-drive with which he can turn upon a pet variable star and find the special star right there in the center of the field of view.

Amateur observers have been keeping track of many variable stars for close on to half a century. The first group of such observers was formed by the British Astronomical Association in England, and known as its Variable Star Section. Under the guidance of Colonel Markwick, some ten or a dozen observers banded together, toward the close of the last century, to carry on coöperative work in following the changes of a small, selected number of variable stars, some which change their light within a few days, but more especially those which require a year or so to change from bright to faint, and back to bright again.

About thirty years ago a similar group of amateur observers was formed in this country to do the same sort of work as the British observers had been doing, but on a much more extended list of stars. A few of these American observers had, in a desultory manner, been observing variables, but in no concerted fashion. In 1911, at the suggestion of the late Professor H. C. Wilson, then Editor of POPULAR ASTRONOMY, and with the encouragement and assistance of Professor E. C. Pickering, then Director of Harvard College Observatory, Mr. William Tyler Olcott organized a group of amateur, variable star observers.

Starting with a small group, not over a dozen, contributing only a few hundred observations per month, this organization has grown to nearly two hundred observers, and, instead of being confined to Ameri-

ca, it may now be considered as world-wide, with regular contributors in Europe, Asia, Africa, Australia, Canada, and Mexico. Instead of a few hundred observations per month they now number several thousands, and in the nearly thirty years of its existence the members have accumulated over three-quarters of a million observations.

Let us describe a few of these enthusiastic variable star observers. In St. Petersburg, Florida, there is a retired clergyman, by name T. C. H. Bouton, now in his 85th year, who was one of the first to join the ranks of the A.A.V.S.O., as the American Association of Variable Star Observers is now familiarly known. The Reverend Mr. Bouton began observing while a resident of Hudson, New Hampshire, and, save for a few months each year, he has been a regular observer of these interesting variable stars. He has proven that in spite of advanced years his eye is as keen as ever. He observes with a 7-inch refractor in his home-made observatory, and, besides variable star observing, he finds time to demonstrate the other celestial wonders to the many visitors to his observatory. To date he has contributed over 20,000 observations and few months pass without the appearance of "B" in the column of observers in the published results. May he continue to keep track of the stars for many years to come!

Probably the best known among American amateur observers is Mr. Leslie C. Peltier of Delphos, Ohio, not only as a variable star observer of repute, but also as a comet and nova discoverer. With a short-focus 6-inch telescope at his disposal, Peltier has found numerous comets and has been the co-discoverer of several novae, or new stars. He has been observing for more than twenty years and was the first to be given the A.A.V.S.O. Award of Merit for outstanding contributions to the study of variable stars.

Another astronomical tyro is Eugene H. Jones of Goffstown, New Hampshire, now retired from the active pursuit of earning a livelihood, who spends his days as a landscape artist, and his nights as a star-gazer. For more than sixteen years, Jonesy, as he is more commonly known, has been keeping up his nightly vigils and during these years only one month has passed without a report from him. This was due to illness, not to lack of interest. Without his variable star observing, Jonesy, now approaching his four score of years, would find life rather monotonous, to say the least.

The names of many amateur observers who have made valuable contributions to variable star astronomy could be mentioned; some still living, others who have passed on. Among these the names of Edward Gray, G. B. Lacchini, J. Ernest G. Yalden, Charles C. Godfrey, Charles Y. McAteer, William Tyler Olcott, David B. Pickering, Joseph Meek, Walter Houston, D. F. Brocchi, R. N. Buckstaff, and Morgan Cilley stand out prominently. Ladies have a place in the list, too, including Caroline E. Furness, Anne S. Young, and Winifred C. Kearons.

In foreign countries we have Radha G. Chandra, Customs Official of

Bagchar, India. Mr. Chandra, now in his sixtieth year, who has been aiding in the variable star work since 1919, has accumulated probably more observations on variable stars than any other A.A.V.S.O. foreign observer, well over 50,000.

Those varying stars in the southern hemisphere are well looked after by such experienced observers as Ensor, Houghton, de Kock, and Cousins in South Africa. Australia, too, has a corps of able observers; Dr. J. M. Baldwin of Melbourne, who, although a professional astronomer, feels that this sort of work is an important branch of astronomical research; and Mark Howarth and Mrs. Rosina Dafter. In Mexico we have two excellent observers, Señores Escalante and Maupomé, while from Japan come observations regularly from Messrs. Yamada, Yamasaki, and Kanda. Canada is included with the work of Bert Topham. The little country of Greece contributes its mite, and from sunny Italy come literally thousands of observations each year from Eppe Loreta of Bologna.

The vocational interests of the observers are wide and varied. Among the observers are teachers and students, lawyers, architects, doctors and dentists, clergymen, mechanics, engineers, manufacturers, farmers, retired gentlemen of leisure, librarians, and also housewives. In age they range from those in their teens to octogenarians. Some observe with small refracting telescopes, having three-inches of aperture or less, while others enjoy the benefits of large reflectors of fifteen-inches or more in diameter. Telescopes of even larger size would help materially in keeping watch on the faintest variables.

So far I have described at length the personalities found in the ranks of the A.A.V.S.O. mainly because it has been my good fortune to have been intimately acquainted with them for a quarter of a century. Doubtless equally interesting facts could be given about members of other variable star organizations, those in England, France, Denmark, Russia, Japan, Australia, and New Zealand, if they were as intimately known to me.

What about some of the stars and their actions which are being observed by amateurs? Rest assured they present many thrills. Many types of variation are to be found in the 500 to 600 or more stars which are being so completely watched. The majority of these stars are bright, and of the class known as long-period. They go through their light cycles in about a year, some just under, and a few a bit over, 300 days. Some of them become easily visible to the naked-eye at their brightest phase and at their faint stages they fall far below the limit of visibility of all except the largest telescopes. Mira Ceti and Chi Cygni, among the first stars to be found to be variable, are good examples of such stars and are today just as interesting, if not more so, as they were two or three centuries ago.

Mira Ceti, situated in the constellation of Cetus, the Whale, and the first star which proved to be changing in light, has a period of eleven

months and, accordingly, reaches maximum brightness a month earlier each year. In 1939 it reached the third magnitude in August; in 1940 it was at maximum, slightly brighter than the fourth magnitude, in July; while this year it is due to be bright in June, at a time when the star will be unfavorably placed for observations. Mira has, on occasion, been known to attain the second magnitude, but this is the exception rather than the rule.

Chi Cygni, with a period of thirteen and a half months, varies in light over a range of nearly ten magnitudes, a total change of almost 10,000 times in luminosity. It, too, has the habit of rising to different heights at different maxima and frequently presents halts, or still-stands, on its increase from minimum to maximum.

Of particular interest are the so-called anomalous, or irregular, variables. R Scuti, for example, has a sort of regularity in period—145 days—but on occasion presents a deep minimum where a shallow one was expected and even, at times, shows a brighter than normal maximum where a real minimum was to be looked for.

Probably the best case of abnormality was that of R Coronae Borealis, which for ten years remained at practically constant brightness—just visible to the naked-eye at the sixth magnitude—and then, without any warning, faded away in a few weeks to the fourteenth magnitude, visible only in the largest telescopes. What perseverance on the part of the observers it must have required to watch for this great drop in light, especially for him who had never seen the star fade away! But herein lies the fascination of variable star observing.

Then again take the star SS Cygni, usually faint, of the twelfth magnitude. Here we have a star which for weeks at a time shows little evidence of change and then suddenly—often within twenty-four hours—becomes four magnitudes brighter and appears as the brightest star in the field of view of the telescope. These sudden outbursts are not in the least regular, in fact decidedly irregular. Sometimes the star stays at maximum brightness for only a day or two, then slowly fades away to resume its normal minimum brightness. At other maxima it remains bright for ten or twenty days, so that you can thus see that observers are always on the alert for the unexpected to happen. If time permitted I could point out many other stars which provide observational thrills.

Probably the most exciting moment to an amateur observer is when he finds a nova, or new star, where none has appeared before. And amateurs have been discoverers of novae, very often before the professionals have found them. The Reverend T. D. Anderson of Scotland was the original discoverer of two bright novae, and co-discoverer of a third. The famous nova of 1934—in the constellation of Hercules—was first seen by an amateur meteor observer in England. In fact most of the brilliant novae have first been seen by amateurs as they seem to have a familiarity with the constellations not usually possessed by the professional astronomer. The A.A.V.S.O. has in the past awarded its David

B. Pickering Nova Medal to several discoverers of novae, and is still prepared to offer another medal to the original discoverer of the next nova found by visual methods. Perhaps one of my listeners of tonight may be that next nova medalist.

I shall now answer certain questions which Mrs. Polk will propose.

MRS. POLK: Mr. Campbell, now that you have told us about the amateur variable star observer and what he can do to add to our information on these interesting stars, perhaps you can tell us what becomes of all the thousands of observations and how they aid the professional astronomer in his problems.

MR. CAMPBELL: Well, Mrs. Polk, as one who is interested in variable stars, such a question is not amiss. These observations, once they have reached me, are plotted, posted, and printed so as to be made available to the whole astronomical world. For many of the stars under observation, our records contain the only historical information available. These records tell us just what the stars have been doing for many years in the past and we hope continued observations will tell us what they are doing in the future.

MRS. POLK: Do professional astronomers apply for information on variables?

MR. CAMPBELL: Yes, on frequent occasions. If an astronomer, say at the Mount Wilson or Yerkes Observatory, desires to compare his observed spectral changes with light changes, all he has to do is to ask us what that variable star was doing at the same time the spectrum observation was made, and in nine cases out of ten we can supply the information, almost at a moment's notice. And, too, they serve as a means of classifying the variables, of which there are many and varied types, with the expectation that sooner or later we may be able to theorize as to how and why they vary in light, and perhaps in the end, form a better picture as to the general problem of the cosmos.

MRS. POLK: Can you tell us briefly how important it is for us amateur observers to continue with this interesting line of visual observing?

MR. CAMPBELL: Yes, visual observations will, for a long time to come, as I see things, be necessary. While the photographic plate still continues to record permanently very important data, there are not enough photographic "eyes" to compete with the work of the layman's eye when it comes to continuity of observations. The distribution of visual observers over the entire globe is essential for the almost continuous records which must be maintained on certain types of stars, if we are to know what is taking place in these stars from night to night, as well as from week to week.

MRS. POLK: If there is still time, perhaps you can tell us how many kinds of variable stars there are, that is the principal types.

MR. CAMPBELL: Yes, there are five different, main classes of variables.

First: The so-called novae, which are, in reality, not new stars in the ordinary sense of the word but instead are the result of sudden outbursts of very faint stars.

Second: The red-variables—those giant stars which have large, extended atmospheres with small, dense cores at their centers.

Third: The pulsating stars which fluctuate in perfect rhythm in periods of a few hours to several days or weeks.

Fourth: The erratic stars, or those which apparently are forever doing the unexpected in their light variations.

Fifth: The eclipsing stars which are not intrinsically variable but change their light only because of the fact that in their rotations around a common center of attraction one component of the system is eclipsed by the other.

MRS. POLK: Are more observers needed?

MR. CAMPBELL: More amateur observers are needed, especially just now when the chaotic world conditions appear to have disrupted, for the present at least, this important field of research. The work is not difficult, stick-to-itiveness and a natural aptitude for recognizing stellar configurations are the main essentials. The A.A.V.S.O., in particular, is in a position to supply instructions and observational material. To the interested amateur I say, if you can secure a telescope of even moderate size and have the will to try, perhaps we can train you as an amateur observer of variable stars.

The Origin of the Minor Planets and of the Comets*

By EMILE BELOT

To my knowledge, no astronomer has exactly described the origin of the minor planets and the comets. Often these two kinds of celestial objects are confused with one another because of the large eccentricity of their orbits.

1. My dualistic cosmogony, presented to the Academy of Sciences of Paris in 1905 by Henri Poincaré, proved that the planetary system owes its origin to the collision, at a velocity of 2000 kilometers per second, of a giant sun with a rather dense dark nebula. The original sun, much flattended by its rotation, was, by this collision, caused (as in the case of a nova) to pulsate, expanding periodically at the equator, and emitting at each pulsation a planetary ring in the plane of the ecliptic across the nebula with the same velocity as that of the sun. For the

*Translated from the French by Mr. Thomas D. Bowie, Carleton College, Northfield, Minnesota.

same physical reason that causes a smoke ring to expand when rising in the air, each planetary ring hurtling forward in the nebula increased in radius until it attained that of a planetary orbit in the ecliptic. But the collision had produced on the surface of the solar nova a temperature of 24,000 degrees, which had given to it a repulsive force 600,000 times the pressure of the radiation of the sun, which had the effect of repelling far from the trajectory of the sun the gas and the light, whitish particles which furnished the enormous masses of Jupiter and Saturn.

2. Cause of the Small Mass of the Group of Small Planets. The powerful ring, the condensation of which was to produce Jupiter, attracted by its mass all the elements of the nebula which it encountered in rising in the ecliptic. Its mass was further augmented by all the nebulous elements repelled by the pressure of the radiation. Thus the region of the nebula, to which the ring of the small planets was to rise after the pulsation had produced the ring of Jupiter, was, as it were, emptied of matter. The law of planetary distances,

$$X_n = 0.29 + 1.886^n/214.95 \text{ (in astronomical units)}$$

which our cosmogony was able to demonstrate in 1905, gives very exactly, for $n = 12$, the distance of Saturn; for $n = 11$, that of Jupiter; for $n = 10$, the distance 2.939 where in the ecliptic the ring of small planets would have formed a condensed planet. Furthermore, this distance is very near to the aphelion distance of Ceres (2.985) which is, indeed, the minor planet with the greatest mass.

3. Cause of the Dispersion of the Minor Planets Arising from the Ring, X_{10}. The repulsive force of radiation of the sun produced in its wake in the nebula an envelope E (Fig. 1) at the distance where the repulsive force was equal to the attraction for the nebulous particles of mean density. In listing the aphelia of minor planets in a plane perpendicular to the ecliptic, one sees clearly the outline of this envelope E passing through the aphelia of Vesta, Ceres, and Juno. On crossing this line moving outward the numerical density of the minor planets suddenly doubles, which shows that the ring X_{10} was broken on this envelope E which it met at points far distant from the ecliptic.

4. The Double Origin of Planets. In 1908 I discovered, from the list of aphelia, the Martian group, composed of Adalberta (330), of Eros (433), and of Hungaria (434), outlining the axis of Mars. As was already known, the Jovian group, Nestor, Priam, Achilles, Hector, and Patroclus outline the axis of Jupiter. I was thus able to foresee in 1911 that the minor planets of the Saturnian group would be discovered. The first and only one known was discovered in 1920, namely Hidalgo (944) which is in effect situated on the prolongation of the axis of Saturn. Its aphelion distance is 9.346.

Where did these little planets come from? The first term of the law of distribution of satellites of each large planet gave me the axis of the vortex the condensation of which was to produce the planet. However,

such a vortex is a linear arrangement of matter, hence unstable from the point of view of gravitation. It must therefore divide into parts which constitute small planets in the wake of large planets. One sees that their origin is quite different from that of those which are the result

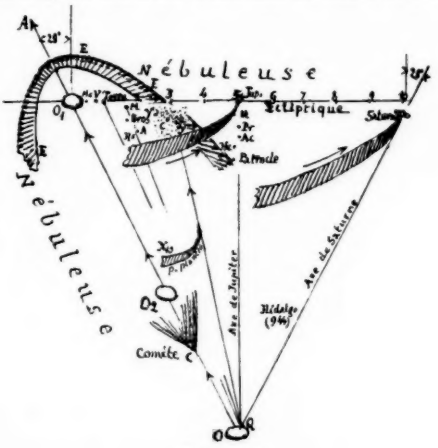

FIGURE 1

O—Original Sun, a Giant Star moving in the direction OA in the nebula.

E—Envelope of nebulous masses repelled by the pressure due to the radiation of the sun.

X_{10}—Ring which produced the minor planets in breaking on the envelope E.

Q—Point of convergence of axes of the principal planets. (Law of inclinations of planetary axes discovered in 1905 by Emile Belot.)

O2—Formation beyond A in the wake of the sun of the cometary nucleus C by periodic convergence of the nebulous masses attracted by O2.

of the ring X_{10}. An interesting present-day problem would be to investigate the small planets, discovered recently, according to the category to which they belong. Thus Amor (1221), aphelion distance 2.789, and Adonis (1936 C. A.), aphelion distance 3.322, belong to the central ring X_{10}. On the other hand Apollo (1932 HA), aphelion distance 2.3330, and Hermes (1937 UB), aphelion distance 1.8963, belong to the Martian group.

5. ORIGIN OF COMETS. While the 15 rings, necessary to produce the large planets and the zodiacal rings while rising in the nebula, swept away all the nebulous matter encountered, the sun, whose reduced energy no longer permitted it to emit any planetary ring, continued, however, its pulsation in the heart of the nebula. The nebulous particles could thus converge periodically at points C (Fig. 1) which formed

cometary nuclei in the wake of the sun. [In order not to prolong the figure on the side A, the formation of a cometary nucleus has been plotted on O_2C; but it is in reality on the prolongation of OA and beyond the ecliptic that the comets are formed in the wake of the sun.] The cometary nuclei will be formed from the matter of the nebula only, while the planetary rings would contain at the same time matter from the sun and from the nebula. The spectrum of comets (if the solar spectrum reflected by comets near the sun is omitted) confirms our previsions, for it is characterized by bands fading towards the violet and related to the carbon compounds. The number of cometary nuclei may be enormous (without doubt more than 100,000), for the sun traversed the nebula for about two hundred centuries before leaving it. The inclination of cometary orbits can be considerable since the trajectory OA of the sun made an angle of 28° with the axis of the ecliptic. From the manner of formation of the cometary nuclei, one can thus see that their orbital eccentricities can be very great.

6. Conclusions,—Russell's Theory of Stellar Evolution Confirmed by Our Dualistic Cosmogony. The first term (0.29UA) of the law of distances is equal to 62.3 times the sun's radius. The original sun was, then, a giant star and, according to Russell's theory, it resulted from the condensation of a supergiant star having a radius 214.95 times that of the terrestrial orbit. It was during this condensation that the supergiant accelerated its rotation to the point of reducing itself to a much flattened ellipsoid whose polar axis was only 38.6 times the solar radius and whose equatorial velocity (55 kilometers-second) by it centrifugal force at the equator was ready to permit the planetary rings to escape. But it was the enormous repulsive force of the radiation of the sun, which, in giving to Jupiter a great mass, reduced the mass of the minor planets (and also the mass of Mars) and produced the envelope E, mentioned above, on which their ring X_{10} broke itself.

One cannot understand the origin of comets without taking into consideration the attraction and pulsation of a giant star passing through the primitive nebula. This nebula contained dense particles (uranium, thorium, lead, etc.) which have produced radioactivity in certain meteorites and in a thin layer (according to Joly) of the earth's crust. The age calculated by *radioactive minerals* of the earth's crust is thus *the age of the nebula* and *not that of the Earth* which is not more than 350 millions of years.

It would be desirable for the observers of the minor planets to classify them according to their two distinct categories, and to search for the minor planets of the Saturnian group which exist between the ecliptic and Hidalgo (944). From the figure, it appears unlikely that there are small planets between the central group X_{10}, that of the Jovian Group extending to Patroclus, and the Saturnian Group aligned near the axis from Saturn to Hidalgo.

Paris, France, February 22, 1939.

Planet Notes for September and October, 1941

By R. S. ZUG

NOTE: Greenwich Civil Time is employed unless otherwise stated. To obtain Eastern Standard Time subtract 5 hours, Central Standard Time, 6 hours, etc. The planetary phenomena are described as they are to be seen from latitude 45° N. The data are taken chiefly from the *American Ephemeris and Nautical Almanac*.

Sun. The sun will be moving through the constellations Leo and Virgo during September and October. The sun will reach the autumnal equinox September 23, $10^h\ 33^m$, at which instant the season of fall begins.

Moon. Phenomena of the moon will occur as follows:

		h	m
Full Moon	Sept. 5	17	36
Last Quarter	13	19	31
New Moon	21	4	38
First Quarter	27	20	9
Full Moon	Oct. 5	8	32
Last Quarter	13	12	52
New Moon	20	14	20
First Quarter	27	5	4
Apogee	Sept. 11	13	
Perigee	23	10	
Apogee	Oct. 9	6	
Perigee	21	14	

Eclipses. A partial eclipse of the moon will occur on September 5. The eclipse will be invisible in the western hemisphere except the beginning, which will be visible in the extreme northwestern portion of North America.

A total eclipse of the sun will occur on September 21. The path of totality begins in South Russia and extends southeastward across Asia and the Pacific Ocean as far as longitude 176° 39′ E., latitude 9° 58′ N. At Manila, Philippine Islands, the eclipse will reach a magnitude of 72% at 4:59 G.C.T. At Nome, Alaska, the eclipse will reach a magnitude of 3% at 4:48 G.C.T.

Circumstances of these two eclipses and a chart of the solar eclipse, may be seen by reference to POPULAR ASTRONOMY for January, 1941, pp. 25-27.

Mercury. Mercury reaches greatest eastern elongation October 3, 5^h, and, for a few days preceding and following this date, will be distinguishable in the evening sky, but with difficulty due to the southerly declination of the planet at that time.

Venus. Venus will be an evening star, of increasing brightness and elongation from the sun, during September and October. The planet will be seen in the evening sky, at a low altitude, however, due to the southerly declination. For the distance of the planet, its angular diameter, etc., reference may be made to page 30 of POPULAR ASTRONOMY for January, 1941.

Mars. Mars reaches oppostion on October 10, 13^h. The time of closest approach to the earth is October 3, 7^h, when the distance of the planet will be 38,130,900 miles. The planet will be in retrograde motion near the southern border of the constellation Pisces during the months of September and October, and will reach a maximum brightness corresponding to stellar magnitude —2.4 at near

opposition. The present opposition will be the most favorable for observation of Mars for the next fifteen years. The occasion is especially fine for observers in the northern hemisphere due to the fact that Mars will be located north of the celestial equator and will therefore reach a high meridian altitude. The southern hemisphere of the planet will be more directly seen than the northern, the south pole being visible from the earth.

Numerical data pertaining to Mars are listed below:

Date 1941	Distance from Earth (miles)	Angular Diameter	Declination	Stellar Magn.
Sept. 1	44,431,000	19".6	+4°.9	—1.7
15	40,347,000	21.6	+4.9	—2.0
Oct. 1	38,169,000	22.8	+4.1	—2.4
15	39,128,000	22.2	+3.2	—2.3
Nov. 1	44,144,000	19.7	+2.9	—1.9

A chart with accompanying information, which will enable observers to compute the Martian longitude and latitude of the center of the planetary disk at any time and to identify the surface markings visible at any time, may be found on pp. 30-32 of POPULAR ASTRONOMY for January, 1941. A few reprints of this article, "Planetary Phenomena in 1941," are still available and will be furnished to anyone upon receipt of request and two cents for postage.

Jupiter. Jupiter is now a morning star. The planet will reach western quadrature on September 13. After October 10, the apparent motion of the planet will be retrograde.

Saturn. Saturn is a morning star, located in the constellation Taurus, just south of the Pleiades. This planet will be a fine object for telescopic examination during the coming opposition (date of opposition Nov. 17) as its declination is 17° N. and the ring system is favorably oriented.

Uranus. Uranus is located in the constellation Taurus, just south of the Pleiades, and not far from Saturn. A chart illustrating its apparent motion relative to stars appeared in POPULAR ASTRONOMY for January, 1941, p. 34.

Neptune. Neptune reaches conjunction on September 20.

Asteroid Notes

By HUGH S. RICE

Ceres is at the Sagittarius-Ophiuchus-Scorpius boundary during the late summer of this year. On the evening of August 1, the asteroid is about 1½° west of the variable star X Sagittarii, and on August 13, 2° nearly west of the same star, at the stationary point. From this place it begins its direct motion, passing south of X about September 4, and being about 1° northeast of W Sagittarii on September 30. The magnitude changes from 7.9 to 8.6 during the two months, and hence is suited to observation with a small glass. It is in a rich region of the sky which affords various interesting telescopic objects for summer evenings.

Pallas, while still observable in southwestern Hercules, is becoming so faint as to be almost in the 10th-magnitude class and therefore difficult to locate without a chart or an ephemeris. On the evening of August 5, its R.A. is $16^h\,7^m$, and Decl. +19° 18′; on September 2, R. A. $16^h\,22^m$, and Decl. +14° 8′; on September 30, R.A. $16^h\,47^m$, and Decl. +9° 31′, or 2° west of χ Ophiuchi.

Besides Ceres and Pallas, the next brightest minor planets for observation at this time are those whose ephemerides we give below, as furnished by the Copernicus-Institut:

EPHEMERIDES OF ASTEROIDS, FOR 0^h U.T. EQUINOIX 1950

1941	80 Sappho 9M.3 α h m	δ ° ′	29 Amphitrite 9M.1 α h m	δ ° ′
July 25	21 47.7	+ 4 37		
Aug. 2	21 43.3	+ 4 46	Aug. 2	22 10.3	—17 25
10	21 37.5	+ 4 33	10	22 3.5	—17 51
18	21 31.2	+ 3 58	18	21 56.0	—18 14
26	21 25.0	+ 3 4	26	21 48.3	—18 33
Sept. 3	21 19.7	+ 1 58	Sept. 3	21 40.9	—18 47
			11	21 34.2	—18 51

1941	68 Leto 9M.3 α h m	δ ° ′	39 Laetitia 8M.8 α h m	δ ° ′
Aug. 26	23 55.6	—13 42		
Sept. 3	23 50.0	—14 13	Sept. 11	0 51.5	— 2 7
11	23 43.4	—14 39	19	0 46.8	— 3 22
19	23 36.3	—14 55	27	0 41.5	— 4 39
27	23 29.5	—15 0	Oct. 5	0 35.8	— 5 51
Oct. 5	23 23.6	—14 56	13	0 30.2	— 6 55
			21	0 25.3	— 7 46

Hayden Planetarium, American Museum of Natural History,
New York, N. Y., July 16, 1941.

Occultation Predictions

(Taken from the *American Ephemeris*)

Date 1941	Star	Mag.	IMMERSION Greenwich C.T. h m	a m	b m	Angle E from N °	EMERSION Greenwich C.T. h m	a m	b m	Angle E from N °
OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′										
Sept. 1	BD—18°5079	6.5	2 0.5	—1.4	+0.7	45	3 3.5	—1.9	—1.8	300
12	179 B.Tau	6.0	4 40.4	—0.6	+1.2	103	5 40.0	—0.4	+2.5	224
14	130 Tau	5.5	5 1.1	+0.6	+2.8	33	5 40.8	—0.7	+0.1	311
15	26 Gem	5.1	6 38.2	+0.1	+2.5	51	7 31.5	—1.0	+0.3	302
27	95 B.Sgr	5.8	23 51.3	..	..	23	0 29.2	..	..	327
28	BD—19°5047	6.9	0 37.1	—2.1	—2.1	132	1 26.6	—0.7	+0.7	214
30	31 B.Cap	6.4	2 20.4	—1.5	—0.3	73	3 36.4	—1.1	—0.6	252
30	BD—13°5897	6.2	23 2.1	—1.5	+2.0	49	0 16.2	—2.0	+0.3	280
Oct. 1	18 Aqr	5.5	3 35.0	—1.6	—0.9	90	4 44.4	—0.7	+0.2	227
2	150 B.Aqr	6.1	5 3.0	—0.3	+1.9	16	5 48.8	—1.7	—2.9	297
7	ξ^1 Cet	4.5	2 23.3	—1.8	+0.1	124	3 3.9	—0.1	+3.9	190
8	3 B.Tau	6.4	10 18.2	—1.2	+0.1	56	11 25.2	—0.6	—2.0	282
11	117 Tau	6.0	3 12.4	—0.5	+0.4	126	3 56.0	+0.2	+2.8	214
12	292 B.Ori	6.5	4 38.9	—0.2	+1.8	76	5 46.0	—0.8	+1.2	272
25	187 B.Sgr	6.4	20 28.5	—1.8	0.0	111	21 41.4	—1.8	+0.7	239
27	95 B.Cap	6.0	19 41.3	—1.1	+1.9	65	20 53.9	—1.4	+0.9	273
30	342 B.Aqr	6.5	21 15.6	—0.8	+0.2	128	21 51.3	—0.5	+3.5	191

OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′

Sept.	1	BD—18°5079	6.5	1	24.0	—2.0	+1.7	45	2	27.8	—2.2	—1.3	308
	4	λ Cap	5.4	8	6.2	—1.2	—1.0	88	9	10.2	—0.4	+0.1	228
	12	179 B.Tau	6.0	4	32.8	+0.1	+1.2	93	5	29.9	0.0	+1.9	237
	15	26 Gem	5.1	6	38.7	+0.7	+2.6	38	7	17.5	—0.5	—0.2	314
	27	95 B.Sgr	5.8	23	11.4	..	..	28	23	52.4	..	..	330
	28	BD—19°5047	6.9	0	0.8	—2.2	—1.1	128	1	2.4	—1.7	+0.9	225
	30	31 B.Cap	6.4	1	47.1	—1.9	+0.8	60	3	9.8	—2.0	—0.5	267
	30	53 B.Aqr	6.5	22	13.8	..	..	16	22	44.2	..	..	324
	30	BD—13°5897	6.2	22	34.3	—1.0	+2.1	56	23	42.0	—1.3	+0.8	280
Oct.	1	18 Aqr	5.5	3	0.7	—2.0	+0.4	74	4	23.9	—1.6	+0.1	242
	7	ξ^1 Cet	4.5	2	2.4	—0.5	+0.9	109	2	52.1	—0.2	+2.7	208
	7	25 Ari	6.5	12	11.8	—0.4	—2.0	110	13	7.1	—0.3	+0.2	226
	8	3 B.Tau	6.4	9	48.9	—1.8	+0.5	62	11	11.4	—1.5	—1.3	269
	12	292 B.Ori	6.5	4	35.8	+0.3	+1.7	66	5	32.3	—0.3	+0.9	282

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′

Sept.	1	BD—18°5079	6.5	0	24.8	—1.2	+1.6	74	1	34.7	—1.3	+0.3	291
	1	BD—18°5155	6.3	6	50.9	—1.6	—1.3	103	7	56.8	—0.6	0.0	234
	4	λ Cap	5.4	7	19.2	—1.9	+0.7	61	8	42.7	—1.8	—0.1	251
	18	ξ Leo	5.1	11	17.2	+0.1	+0.8	101	12	14.5	—0.3	+0.8	278
	24	6 B.Lib	6.2	1	51.1	—1.1	—2.3	142	2	42.7	—0.7	—0.5	245
	26	24 Sco	5.0	4	20.8	—0.8	—1.0	89	5	23.8	—0.4	—1.2	274
	30	31 B.Cap	6.4	0	48.7	—1.6	+1.8	62	2	5.8	—1.9	+0.4	279
	30	τ Cap	5.3	7	46.1	—0.6	+0.1	52	8	47.6	—0.6	—1.3	271
Oct.	1	18 Aqr	5.5	2	1.1	—1.6	+1.8	63	3	23.7	—2.1	+0.7	264
	7	25 Ari	6.5	11	48.3	—2.1	—3.5	126	12	38.5	—1.2	+2.9	200
	8	3 B.Tau	6.4	8	46.7	—1.7	+2.4	47	10	13.8	—2.6	—0.1	270
	10	318 B.Tau	5.7	14	42.9	—1.4	—0.9	85	15	59.8	—0.8	—1.5	274
	11	130 Tau	5.5	14	42.6	—1.4	—2.7	128	15	51.5	—1.7	+0.2	239
	25	*Y* Sgr	5.8	3	26.5	—0.8	—0.1	58	4	27.2	—0.9	—1.7	287
	26	45 Sgr	6.0	3	56.7	—2.1	—2.8	131	4	38.3	0.0	+1.6	203
	26	ρ Sgr	4.0	4	10.8	..	..	14	4	42.5	..	..	320
	28	53 B.Aqr	6.5	5	39.0	—1.0	+0.1	58	6	48.8	—0.8	—0.9	260
	28	BD—13°5897	6.2	6	18.9	—1.3	—1.4	100	7	17.0	—0.1	+0.6	218

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

With the coming of July meteor observers can look forward to nights on which conditions are comfortable and meteor rates increase. Two showers can be depended on: the Delta Aquarids, maximum about July 28/29, and the Perseids, maximum about August 11/12. The first has a radiant about 16° south of the celestial equator and obviously would be a shower better to observe in the Southern Hemisphere. But this very fact has made it difficult for European observers, whose latitudes average farther north than for us in the United States. As so few observers live in the Southern Hemisphere, the shower should be more closely studied than it has been. I strongly recommend, therefore, that our observers begin work on it by July 26/27 and continue right on, because while the Aquarids will doubtless begin to decrease in numbers by July 30/31, at the same time the Perseids will be on the increase, so that total rates should be good. The moon is new on July 24, hence totally out of the way, giving the best conditions for the Aquarids. This, however, means full moon on August 7, just when the Perseids are nearing maximum. Hence this shower will be handicapped by moonlight. In this case, their rates are large enough and brighter meteors frequent enough to justify a full program of observations during several nights, despite moonlight. This year I suggest beginning on August 11/12 and trying for at least the next three nights. With the average amount of cloud in August, this would mean not more than two out of the four nights would be available at one station. A.M.S. members are urged to write in advance for maps and blanks that they may need as there may be more trouble about promptly filling requisitions in the summer, due to a smaller staff and absences on vacation.

A report by E. E. Friton, for the Missouri-S. Illinois group, which just came in, will add 669 meteors to the 1940 total. A few others have also turned up, and later a detailed list of these belated 1940 reports will be published. The number given in our annual report will hence be somewhat increased.

Fireball of 1941 February 26/27

A brilliant fireball crossed the western section of New York State, roughly from N.E. to S.W.; on the evening of 1941 Feb. 26 at 7:30, E.S.T. The object appeared over the territory for which Claude H. Smith of Waterloo, N. Y., has during recent years been the A.M.S. regional director. He therefore at once consulted local papers which efficiently aided him in printing requests for reports. By this means along with numerous personal letters, followed by distribution of A.M.S. Bulletin No. 13 to the more promising observers, he collected several scores of reports, which, after working up and making a preliminary plot, he sent to me. Meantime, I had received perhaps two dozen reports from this and neighboring states, as the object had been brilliant enough to attract attention as far south as Delaware. Thanks to Smith having already done so much of the hard work, I have finished the case more quickly than usual and herewith present the tabular results, followed by some description.

Date	1941 Feb. 26/27, 7:30 P.M., E.S.T.
Sidereal time at end point	85°.1

Began over	λ 76° 21′ W ; ϕ 44° 26′ N at 136 ± 32 km
Ended over	λ 78° 54′ W ; ϕ 41° 57′ 61 ± 18 km
Length of path	359 km
Projected length of path	345 km
Radiant (uncorrected)	$a = 215°$; $h =$ 15°.4
Zenith attraction (parabolic)	−2°.9
Radiant (corrected)	$\alpha = 209°$; $\delta = +48°$
Duration of train (maximum reported)	15 minutes

For the observers anywhere near the path the fireball was estimated at from ¼ of to equality with the full moon in apparent size. A diameter of 12′ probably would be about the average of the estimates. As usual, the variety of colors given was large, but most of the better reports emphasize blue as being predominent. Towards the end, there was perhaps more yellow or red. The train was described as reddish or yellow at first, with particles. This would indicate that small fragments of the body itself were left along the course, which perforce quickly cooled and became invisible. Then the true long-enduring train appeared which was white or smoky colored and lasted, for the most favorably placed observer, about 15 minutes in the part where the glow persisted longest. While there was certainly a flare up or two along the course, and perhaps at the end, there was no actual explosion. No sound phenomena are reported by the better observers. Any attempt at determining the velocity is greatly complicated because many of the observers do not clearly differentiate, in their reports, between the time taken by the fireball in describing its course, the time the fragment train was visible, and the duration of the long-enduring train. The concensus of the better reports, however, indicates that its visibility was long and hence its velocity moderate if not low. It is too bad that no one attempted to actually time it. In this case the average value of the estimates, for reasons given, means much less than usual and is not worth recording. The parabolic velocity was assumed therefore, as is usual in such cases, for the derivation of the zenith correction. This must be applied to the altitude before the corrected radiant can be computed.

As to the heights and azimuth on which the radiant's position rests, it is believed that the projected path could be determined with considerable accuracy. This is due to the fireball having passed near the zenith of several places, and a nearly perpendicular path being reported. Especially valuable is that from B. R. Blossom at Leicester, N. Y. He not only sent in a completely filled questionnaire, but also a drawing, made on the spot, which shows the shape and drift of the long-enduring train in relation to Ursa Major. As this was the only such report, it was given very great weight. But for this observation, I would have placed the projected beginning point to the S.E. of the place chosen and the azimuth of the path would have been 6° greater. Somewhat more trouble was given by the altitudes, but by four approximations I believe that the less certain were eliminated and the better retained. The average errors are large but not unexpected as only three altitudes could be checked even partially by reference to stars. The rest were "dead reckonings" though in a few cases checked by some form of protractor several days later.

The data on the long-enduring train are so fragmentary that nothing could be said about its drift but for the drawing and report of Blossom. It was mentioned by others and at least one man described it as being broken up by wind currents, which means that he easily saw the drift. Unfortunately no further data are given by him or others. It seems that the lower end was at a height of about 73 km but it is impossible to determine the height of the upper end with any certainty. The

best estimate that I can make is 106 km. The lower end seems to have done the fastest drifting, but according to Blossom's full account the whole train drifted slowly, parallel to itself, which means towards azimuth 285°. The lower end drifted faster, and then, encountering another current, bent back on itself into a hook-shaped figure. I find it most difficult to determine just what direction a current would have had to produce this, but it seems clear that there must have been a strong upward component, though of relatively small cross section, a little to east of the lower part of the original path. When the train drifted so that it was caught by this upward current, the curious hook was formed. Allowing for the earth's rotation, I deduce that the middle of the train, at a height of about 90 km, drifted towards azimuth 285° with a velocity of about 18 km per hour. At the 75 km level the velocity was perhaps twice as large, until the upward component came into play. These velocities are much smaller than usual for these heights. They all depend, as said, upon one drawing, but that fortunately was made while the train was visible.

Again I beg that every person, the least interested in science, never neglect the rare opportunity presented by a long-enduring train. Please make the most careful and detailed observations of its directions of drift and changes of form. If, as usual, caught unexpectedly and with no star map at hand, make sketches on the back of a letter or any scrap of paper, with notes, and as soon thereafter as practicable transfer to a larger sheet and complete the notes. Any one person sees so few in a lifetime that each chance should be improved to the limit. I am most anxious to receive every observation dealing with this type of phenomenon.

Lack of space prevents acknowledgment by name of every report received. Only by such coöperation, however, is it possible to work out such a case as this. The energy and ability of C. H. Smith in collecting, classifying, and partly working up these reports deserve my sincerest thanks. To him especially and to all the observers I express my great appreciation. It is a fine example of what can be accomplished by an active regional director.

Flower Observatory, Upper Darby, Pa., 1941 June 10.

Note on Contraterrene Meteorites[1]

By C. C. Wylie

The following is condensed from an account in the *New York Times* for September 15, 1940, page 52 of the late City Edition.

"Phantom Bertha Shells Sound Boat"

"As the 22-foot cutter-type sailboat Rocket II was crossing Long Island Sound near Bridgeport, Connecticut, yesterday morning with four peaceful persons aboard, a shell screeched across her bow and exploded in the water a hundred yards away.

"The 'screech' came first—an unholy noise. Then, a split second later, the explosion, about two points off the starboard bow. It blew up a great tower of water, 20 or 30 feet in the air.

"National Guard officials at Bridgeport said none of their units was engaged

[1] Read at the eighth annual meeting of the Society for Research on Meteorites, Flagstaff, Arizona, June 23-25, 1941.

in any artillery practice. There are no proving grounds in the vicinity.

"As to the possibility that the object was not a shell at all, but was perhaps a meteorite, it was said at the Hayden Planetarium that a meteorite on striking water would not explode."

The suggestion has been made that this account might be explained as the falling of a meteorite made of "contraterrene" or reverse matter; and the reply has been made that the assumption of contraterrene material is unnecessary,[2] that the account is similar to others which are being received regularly by investigators, on ordinary meteorites.

Explanation of Account

Let us consider the account and its explanation more fully. The account is unusual in one respect. In 90% of the cases, the first sound heard from the meteor is the sharp blast of the detonation. The detonation is not the sound of a true explosion, but the shock wave produced by the meteor while travelling at a speed much above the velocity of sound. The whistle, screech, or hum of the falling meteor is heard after the detonation, usually minutes after. Meteorites weighing 50 pounds or less fall through the lower air with a velocity much less than that of sound, hence the whistle or screech is heard well after the detonations, even by a person close to the point of fall.

A meteorite weighing 100 pounds or a little more, however, falls more rapidly, although in the lower air it is falling with a velocity less than that of sound. For such a meteorite, a person close to the point of fall may hear the sound of the falling meteorite before the arrival of the shock wave from the upper air. This was the case for the Tilden meteorite weighing 110 pounds.[3] The account of the "Phantom Bertha" is remarkably similar to the account of what Mr. Lindsay Mansker heard when the 110-pound Tilden stone fell near his home. The only essential difference is that, as the Tilden stone did not fall in water, he saw no splash.

The "screech," heard first in the Phanton Bertha account, was the noise made by the falling meteorite. War veterans near the point of fall of meteorites have testified to the fact that a falling meteorite sounds exactly like a falling dud shell.

The "explosion" was the sound of the shock wave arriving from the upper air, a little later than the meteorite itself. The falling meteor, travelling literally miles per second, produces in the upper air a cylinder of highly compressed and highly heated air, just as lightning does. When this cylinder, or "shock wave," travelling outward reaches the ear, it sounds like a sharp clap of thunder, or even louder.

The "great tower of water, twenty or thirty feet in the air," was merely the splash of the meteorite. The energy of striking, without any explosion, would be sufficient to throw several hundred cubic feet of water to a height of twenty or thirty feet.

Obviously, the assumption of an ordinary stone meteorite weighing 100 pounds or a little more explains this story completely. Let us consider now what would have happened if the meteorite made of "contraterrene" material, or reverse matter, had fallen into the atmosphere.

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[2] Nininger, H. H., Popular Astronomy, **49**, page 215, 1941.

[3] *Contributions* No. 3, University of Iowa Observatory, page 104.

Energy of a Contraterrene Meteorite

The atoms of our solar system, referred to as "terrene," have positively charged nuclei called protons. About each proton negatively charged electrons move. It has been assumed by theoretical physicists that there might be matter composed of atoms with negatively charged protons about which positively charged electrons move. This hypothetical matter has been termed "contraterrene." If contraterrene matter should come in contact with ordinary matter, the oppositely charged protons and oppositely charged electrons would neutralize one another, annihilating matter and releasing energy. The energy released in this way would be almost unbelievably great, a pound of matter releasing energy the equivalent of seven million tons of nitroglycerin.

Fall of a Contraterrene Meteorite

Evidently, the object falling in Long Island Sound could not have been a contraterrene meteorite. In travelling through only a few inches of ordinary air, a contraterrene meteorite of weight 100 pounds would encounter enough terrene material (air) to produce an explosion equivalent to 15,000 tons of nitroglycerin.

Since contraterrene matter would be neutralized by its own weight, or mass, of terrene matter, it is a simple matter to calculate that, neglecting the enormous release of energy, our atmosphere would neutralize about 136 centimeters of thickness of an iron meteorite. This is obtained as follows:

$$136 \text{ cm.} = 76 \text{ cm.} \times 13.6/7.6,$$

where 76 cm. is the height of the barometer at sea level, 13.6 is the specific gravity of mercury, and 7.6 is the specific gravity of iron.

As indicated in the preceding paragraphs, however, the enormous energy released by the annihilation of matter cannot be neglected. A meteorite the size of the Cape York, 36½ tons, would be blown to pieces by the annihilation of only a single gram of air and meteorite combined, since the energy released would be equivalent to the explosion of 15,000 tons of nitroglycerin. The small pieces resulting, each having considerable surface exposed to the air, would be pulverized and annihilated almost instantly.

The effect would be a single tremendous explosion high in the upper levels of the atmosphere. We can be sure that no well-observed meteor has been of contraterrene material.

Summary

From observations and calculation it appears that the "Phantom Bertha" story is explained completely by the assumption of the fall of an ordinary meteorite weighing 100 pounds, or a little more.

Calculation of the energy released by the union of the hypothetical contraterrene material with terrene material (air) shows that this story cannot refer to the fall of a contraterrene meteorite. Indeed, no well-observed meteor can have been made of contraterrene material.

University of Iowa, June 5, 1941.

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
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Secretary of the Society: C. H. CLEMINSHAW, Griffith Observatory, Los Angeles, and Department of Astronomy, University of Southern California, Los Angeles

Small Aërolites Recovered from the Site of the Holbrook, Arizona, Fall of 1912*

By FREDERICK C. LEONARD

ABSTRACT

This paper includes an account of the recovery and a description of 8 more aërolitic particles, ranging in weight from 0.0628 to 0.0074 g., that were recently collected from ant hills at the site of the Holbrook, Arizona, fall of 1912. (The total number of such specimens now known is 11.) All 8 of these particles were discovered by means of "alnico" magnets—4 of the little stones in the field and 4 of them in the laboratory. The latter were detected in a quantity of 5515 g. of the ant-mound gravel that was brought home for examination, and all 4 of these were found in the material of the same jar, which contained 771 g. of this gravel. From the data available, the ratios of both the numbers and the weights of the terrestrial and the meteoritic stones are calculated and various other comparisons between the 2 kinds of particles are made. Probably the most significant conclusion is that completely incrusted aërolites, weighing down to 0.0074 g., not only have been demonstrated to exist but have actually been reclaimed at the place of the Holbrook shower.

In *C.S.R.M.*, **2**, No. 4, 258-60; *P.A.*, **49**, 159-62, 1941, Dr. H. H. Nininger has described a method of collecting small aërolitic particles from ant hills at the place of the Holbrook, Arizona, fall of 1912 July 19, and also 3 minute aërolites that were recovered there on 1940 April 15. His paper serves as an excellent introduction to the present communication.

On 1940 June 16 and 20, my student-assistant, Mr. Boris Slanin, and I were at "Arntz," the site of the Holbrook shower. We were equipped with 1½-inch "alnico" magnets, with which we proceeded to comb some of the ant hills north of the railroad tracks, in search of small aërolites. In the course of this search, Mr. Slanin was successful in finding 4 meteoritic stones, 2 on each day, having respectively the following weights (as subsequently determined by means of an analytical balance): 0.0628, 0.0424, 0.0368, and 0.0074 g. (sum = 0.1494 g.).[1] These little aërolites are all complete, or nearly complete, individuals. Each is largely covered by the chacteristic dull-black, finely-cracked, fusion crust, but at places where the crust is discontinuous, the light-gray, chondritic interior of the specimen is apparent. A few dull-red spots on the surfaces of the stones are due undoubtedly to the oxidation of included nickel-iron grains. All 4 aërolites are highly magnetic—considerably more so than are many of the abundant, non-

*Read at the Eighth Meeting, Flagstaff, Arizona, June 23-25, 1941.

meteoritic, magnetic constituents of the ant mounds. The *maximum* (overall) diameters of the aërolites were measured and ascertained to be 4.8, 3.6, 3.4, and 1.8 mm., respectively. The 3 largest stones are rather angular and irregular, while the fourth and smallest one is more nearly ellipsoidal.

Because of the adverse meteorological (not meteoritical!) conditions that seem to prevail at Arntz, field work there is possible, as a rule, only under difficulty! In order to obtain some kind of check on the frequency of these tiny meteoritic particles in the material of the ant hills, I decided to take home some of this material and to examine it systematically and at leisure under more favorable conditions indoors. Accordingly, 7 Mason jars full of the ant-hill gravel were transported from Arntz to Los Angeles—5515.3 g. of it in all. This was painstakingly and repeatedly examined, both magnetically and visually, first by myself and later by Mr. Slanin, with the result that, on 1940 July 3, I recovered 3 aërolitic particles, all within a few moments of one another, one a complete stone, the other 2, fragments, and, on July 29, a fourth stone, another fragment—all by aid of a magnet and all in the same jar (no. 2), the weight of whose contents was 770.6 g. If these 4 meteoritic particles had been scattered at random in the material of the 7 jars, the probability that all 4 of them would have been in the same jar is of course $(1/7)^3$ or 1/343! The explanation of the presence of all 4 particles in the same jar is very likely that, while some of the ant hills include a few aërolites, others are quite, or almost entirely, devoid of them. (Experience in the field has tended to confirm this conclusion. While the ant hill from which the material in jar no. 2 was taken contained obviously 4 aërolitic particles at least, the mounds from which the material in the other 6 jars was collected *may* not have contained any!)

The aërolites from jar no. 2 have the following overall diameters: 3.5, 3.4, 2.8, and 2.8 mm., respectively. They have been weighed on an analytical balance and found to have the following weights: 0.0413, 0.0318, 0.0139, and 0.0095 g., respectively (sum = 0.0965 g.).[2] The largest and heaviest stone is a perfect, completely incrusted individual, with a few oxidized spots and tiny hair-like cracks on its surface. It is somewhat irregular but less angular and more nearly spheroidal than is the largest specimen (weighing 0.0628 g.) discovered in the field. The 3 fragments, too, have reddish (oxidized) spots and minute cracks on their fused surfaces and exhibit the usual chondritic interior wherever the crust is lacking. It is a noteworthy but an unexplained fact that the crust of the stones recovered in the field has a perceptibly fresher, darker, and less weathered appearance than has the crust of the stones found at home.

In the course of our magnetic examination of the material of the 7 jars, 996 magnetic, terrestrial particles, having an aggregate weight of 10.6 g., were collected. Many of these particles were black or very dark in color and of a basaltic nature and some of them were difficult with the naked eye to distinguish from aërolites; however, with the least magnification, they could be readily discriminated from the meteorites, which were even more magnetic than they were. Since it is quite improbable that all of these magnetic terrestrial particles were segregated, they must have outnumbered the aërolites at least 250 times and outweighed them more than 100 times. Because many of the non-meteoritic magnetic stones—especially those that were light in color—were exceedingly minute, it is not astonishing that, on the average, they weighed much less than the aërolites.

Under the assumption that 1000 of these ant-hill pebbles weigh on the average slightly less than 20 g., the total number of them in all 7 jars was roughly 280,000,

while the total number in jar no. 2 alone was about 40,000. Inasmuch as only 4 of these particles proved to be meteoritic—and all 4 of these were contained in jar no. 2—the ratio of the number of terrestrial particles to the number of meteoritic particles was evidently 70,000 to 1 for the material of all 7 jars and 10,000 to 1 for that of jar no. 2. Indubitably a better idea of the frequency of the aërolitic particles can be gained from a consideration of the weights involved. The combined weight of the 4 aërolitic particles recovered from jar no. 2 may be taken equal to 0.1 g. Hence, the ratio of the weight of the material in all 7 jars (5515 g.) to the weight of the 4 aërolites is about 55,000 to 1, while the ratio of the weight of the material in jar no. 2 (771 g.) to that of the 4 aërolites contained in it is almost exactly 7700 to 1. It would be rash to conclude that any of the foregoing ratios fixes a limit of any kind to the frequency of the aërolitic particles in the ant-hill gravel at Arntz. A great deal more work of a very exhaustive nature will have to be done before either an upper or a lower bound can be assigned with certainty. The results of the present, preliminary investigation should be accepted as indicating only the *possible order of magnitude* of the frequency of these small meteoritic particles, as concerns either their number or their weight.

For comparison with the dimensions of the aërolites, the maximum (overall) diameters of 300 particles taken from all 7 jars were measured with the following results: largest particle, 6.9 mm.; smallest particle, 1.8 mm.; average of all 300 particles, 3.8 mm. The weight of each of 2 sets of 1000 particles from all 7 jars was determined as follows: 27.6 and 21.8 g. (mean = 24.7 g.), while the weight of each of 3 sets of 1000 particles from jar no. 2 (that containing the aërolites) was measured with the following results: 24.3, 19.2, and 15.4 g. (mean = 19.6 g.). (The weights of various sets of 1000 particles each differ greatly, because of the wide range in weight among the individual particles.) It may be assumed that the average piece of gravel in the 7 jars had a weight of 0.0217 g. and an overall diameter of 3.8 mm. The mean of the weights of the 4 aërolites from jar no. 2 is 0.0241 g. and the mean of their diameters is 3.1 mm. (the diameter of the largest one is only 3.5 mm.). Accordingly, the aërolites were on the average both smaller and heavier than the terrestrial particles with which they were associated—*i.e.*, they had a higher specific gravity, as would naturally be expected.

Although the terrestrial pebbles in the ant hills vastly outnumber the aërolites (in the ratio apparently of 10,000 to 1 at least), meteorites, *if present at all,* are surprisingly easy to find, both *in situ* and indoors—and (with the least magnification) to distinguish from even the black, non-meteoritic, magnetic ingredients of the ant mounds—because of the strong magnetic attraction and the characteristic appearance of the aërolites. As previously stated, the first 3 meteorites from jar no. 2 were recovered all within a few moments of one another and, it may be added, almost immediately after the magnetic examination of the contents of that jar was begun.

Including the 3 diminutive aërolites of weights 0.0518, 0.0248, and 0.0183 g., found by Dr. Nininger in April, 1940, 11 aërolitic particles (of which 7 are complete individuals) have now been collected at the site of the Holbrook fall—all 11 magnetically, 7 in the field and 4 in the laboratory—ranging in weight from 0.0628 to 0.0074 g. As Dr. Nininger has remarked,[3] "The fact that these . . . specimens are the smallest meteorites on record is not in itself important," but it may be significant that *fully incrusted stones,* weighing down to 0.0074 g., not only have been proved to exist but have actually been reclaimed at the place of the Holbrook shower of 1912.

NOTES

[1] The specimens were re-weighed on another balance, many months later, with the following results: 0.0633, 0.0425, 0.0370, and 0.0073 g.

[2] The stones were re-weighed on a different balance, many months later, both singly and collectively, with the following results: 0.0411, 0.0319, 0.0140, and 0.0094 g., when weighed individually, and 0.0964 g., when weighed all together.

[3] *Loc. cit., ante.*

1941 June 1.

A Recently Discovered Aërolite from Rosamond Dry Lake, California* [Abstract]

By WALTER T. WHITNEY,

Frank P. Brackett Observatory, Pomona College, Claremont, California

This aërolite (Rosamond Dry Lake), the eleventh fall to be recorded in the State of California, was discovered on November 24, 1940, by Mr. Albert V. Shatzel, Assistant in the Department of Astronomy of Pomona College, while preparing to make a glider flight from the floor of Rosamond Dry Lake in Kern County, California.

The specimen bears a striking resemblance to certain aërolites recovered in 1936 from Muroc Dry Lake, about 15 miles to the northeast (*C.S.R.M.*, **1**, No. 3, 23-5; *P. A.*, **45**, 273-5, 1937); however, on account of the absence of any other discoveries in this region, the stone is to be listed as a distinct fall and designated as 1181349, Rosamond Dry Lake, Kern County, California. The original weight of the specimen was about 850 g.

The chondritic nature of the aërolite becomes immediately apparent upon polishing, which brings to light also a generous sprinkling of nickel-iron grains throughout the matrix. The matrix appears to be mainly the mineral hypersthene.

Because of the non-typical appearance of the untreated specimen and other circumstances obtaining at the time of its discovery, no search of the region was then undertaken. Moreover, by the time the meteoritic nature of the specimen was established, the unusually heavy rains of the past winter had set in, and the place is still under water.

*Read at the Eighth Meeting.

Meteorites in their Bearing on the Origin of the Surface Features of the Moon* [Abstract]

By CLYDE W. TOMBAUGH,

Lowell Observatory, Flagstaff, Arizona

The nature of the problems regarding the Moon's surface features is introduced by briefly describing the physical conditions known to prevail on the Earth's satellite. The general character of the lunar surface and features of especial interest are illustrated by lantern slides.

The origin of the Moon's craters and *maria* has long been a controversial issue. It still is. Various lunar features are discussed, such as the *maria*, great walled plains, ring plains, craters with and without central peaks, craterlets, cones, bright-ray systems, overlapping craters, partially destroyed and nearly submerged craters, isolated mountain peaks, mountain chains, rills, faults, and valleys. Two opposing theories, involving very different mechanisms, endeavor to explain the origin of these features. Arguments for and against both the volcanic and the

*Read at the Eighth Meeting.

meteorite-impact theory are presented. These summarize also the views of leading selenographers and of a few geologists.

The author then proceeds to show why Professor Shaler's bolide hypothesis of the origin of the *maria* is untenable.

Attention is called to one formation on the Moon which definitely appears to be a terrestrial type of volcano. Another unique lunar formation, called *Wargentin*, also is studied.

The author is inclined to believe that both mechanisms have produced the various lunar features, judging from his own extended telescopic observations of these formations.

Comments on the Spectra of Two Bright Meteors* [Abstract]

By C. O. LAMPLAND,
Lowell Observatory, Flagstaff, Arizona

The accumulation of data on the spectra of meteors is a slow process and only a comparatively few spectra have been photographed. The material is, of course, of interest and importance in researches on meteorites. At the request of a member of the program committee of the Society, a brief report on the spectra of two bright meteors is given.

The spectrum of a very bright meteor was photographed on February 26, 1933, by members of the Harvard-Cornell Meteor Expedition at their station on the Lowell Observatory grounds. At the end of its path, this fireball increased in brightness to magnitude —9. Dr. P. M. Millman reported the measurement of 63 lines and all of these, with the exception of a few at the red end, were identified with the low-temperature lines of iron and nickel. It was the first meteor spectrum with sufficient detail to show clear evidence of the nickel lines.

The spectrum of an unusually bright meteor was photographed by Dr. V. M. Slipher on November 15, 1933. Its outburst was near the zenith and was recorded on a plate taken with his night-sky spectrograph. The dominant lines of this spectrum were H and K, due to ionized calcium.

*Read at the Eighth Meeting.

Election of the Council for the 1941-45 Term

The nominees for the Council for the 1941-45 term, announced in *C.S.R.M.*, **2**, No. 4, 272-3; *P. A.*, **49**, 216-17, 1941, were all duly elected at the Eighth Meeting of the Society, held in Flagstaff, Arizona, June 23-25, 1941, and took office on the adjournment of that meeting. A full report of the meeting will appear, probably in the October issue.

ROBERT W. WEBB, *Secretary, 1937-41*

Comet Notes

By G. VAN BIESBROECK

COMET 1941 *d* (van Gent). On June 5 the Central Bureau of Astronomical Telegrams at Harvard College received from South Africa the announcement of the discovery at the Johannesburg Observatory of a comet by H. van Gent. The first data were as follows:

1941 May 27.96965 R. A. $18^h\,1^m9$, Decl. —40° 7′
Magnitude 11. Central condensation and short tail.
Daily motion $5^m\,15^s$ west, 41′ north.

By the time the report was received on this side of the equator more than a week after the discovery, moonlight prevented observations. Fortunately the better situated southern observers succeeded in keeping track of the object and by June 18 the following orbit, computed by F. J. Bobone at Cordoba (Argentina), was made available:

ELEMENTS OF ORBIT OF COMET 1941 *d* (VAN GENT)

Perihelion passage	1941 Sept. 3.362	
Node to perihelion	$\omega = 84° 13'$	}
Longitude of node	$\Omega = 256\ 42$	} 1941.0
Inclination	$i = 95\ 10$	}
Perihelion distance	$q = 0.8925$ Astr. units	

On the same day a report from Bologna (Italy) was received mentioning an independent discovery by Bermasconi.

Since then this comet has been followed at many observatories. It brightened up rapidly while the distances from both the earth and the sun were decreasing. It showed a sharp nucleus in the center of the round coma and a short tail in a southeast direction. I made the following estimates of brightness on the Harvard Scale with a binocular pushed out of focus so as to make the images of the comparison stars, whose brightnesses are known, appear similar to the diffuse image of the comet.

June 21	$6^M.7$
June 24 and 25	$6^M.4$
June 26	$6^M.3$

This shows that the comet was already at the limit of naked-eye visibility around the end of June. Further increase in brightness is to be expected as can be seen from the following ephemeris computed from a new set of elements by Bobone differing slightly from the first orbit given above.

EPHEMERIS OF COMET 1941 *d*

1941		α h m	δ ° ′	Distance from Sun	Earth	Mag.
Aug.	2	13 7.8	+31 42	1.05	1.09	5.4
	6	13 1.4	33 20	1.01	1.14	5.3
	10	12 55.2	34 49	0.98	1.19	5.2
	14	49.3	36 10	.95	1.24	5.1
	18	43.4	37 23	.92	1.28	5.0
	22	37.5	38 30	.90	1.31	4.9
	26	31.5	39 32	.89	1.34	4.8
	30	25.2	40 28	.88	1.36	4.8
Sept.	3	12 18.8	41 18	.88	1.38	4.8
	19	11 50.2	43 49	0.92	1.38	5.1
Oct.	5	11 16	+45.4	1.05	1.27	5.6

The hypothetical magnitude is computed assuming a variation inversely proportional to the 6th power of the distance from the sun and adopting the magnitude 6.4 for June 25. It will be seen that the comet should be fairly bright during August and September traveling through the constellation of the Hunting Dogs. The high declination will make it possible to follow the comet through its perihelion passage on September 3 and through its conjunction with the sun later in September. It will be of interest to make careful estimations of the total brightness of the comet by comparison with neighboring stars of nearly the same intensity, either with the naked eye or extrafocally with a binocular. Dr. N. T. Bobrovnikoff, Director of the Perkins Observatory, Delaware (Ohio), has shown recently in No. 15 of the *Contributions* of the institution, that observations made

in this manner are much more accurate than is generally assumed. Of course in order to combine the data furnished by different observers using a wide variety of instrumental equipment, reductions to a uniform system are required. Dr. Bobrovnikoff has discussed several thousand observations of cometary brightnesses for that purpose and succeeded in standardizing these results. This will furnish the material for investigating the laws of variation of these light-intensities, which are still very uncertain. The results of this investigation promised for the near future are awaited with great interest.

No further observations have become available on the faint COMET 1925 II (SCHWASSMANN-WACHMANN No. 1) and it seems that COMET No. 3 of the same observers (1930 VI) will not be recorded at this year's return.

PERIODIC COMET 1934 I (WOLF) which comes back to perihelion next year might possibly be reached now with large telescopes. The following ephemeris, computed by M. Kamienski of Warsaw (Poland), gives the position in the constellation of Ophiuchus.

EPHEMERIS OF COMET 1934 I (WOLF)

1941	α h m s	δ ° ′
Aug. 10	17 55 56	+11 28.5
14	55 8	11 2.9
18	54 40	10 35.6
22	54 32	10 6.9
26	54 46	9 37.0
30	55 20	9 6.3
Sept. 3	17 56 14	+ 8 35.3

After several months of interruption in the visibility of COMET 1941 *c* (PARASKEVOPOULOS-DE KOCK) while it was passing behind the sun, this object has now been picked up again in the morning sky. I recorded its presence on plates taken July 4 and 6 which showed it near the position predicted from Bobone's elements (see p. 336) but the brightness estimated as equivalent to a $15^{M}.5$ star is much below what was anticipated. This object continues to fade as it recedes from the sun but it will probably be followed for some time longer while the region gradually moves away from the morning sky.

Williams Bay, Wisconsin, July 10, 1941.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By LEON CAMPBELL, Recorder

Vassar Meeting of the A.A.V.S.O.: May 30 and 31 marked the third Vassar meeting of the A.A.V.S.O., previous meetings having been held there in the spring of 1921 and of 1928. In the absence of Dr. Maud A. Makemson, whose presence was regrettably prevented, Dr. and Mrs. Boris Karpov acted as hosts, not only to the variable star observers but also to a group of enthusiastic amateur astronomers from New York City, members of the Amateur Astronomers Association, under the leadership of Mr. Charles A. Federer, Jr., Editor of *The Sky*.

By late Friday afternoon about thirty A.A.V.S.O. members had gathered at the Observatory, most of whom were later entertained at a picnic supper at the

nearby home of Secretary and Mrs. David W. Rosebrugh. The Council met at 4:00 o'clock and transacted considerable business, including the election of seven new members.

Open House was held at the observatory Friday evening where members of both organizations were privileged not only to inspect the very complete teaching equipment of the Vassar Department of Astronomy, but also to have the opportunity, under ideal sky conditions, to test their eyes on actual variable star observing with several of the telescopes.

The business session of the Association was held in Blodgett Hall on Saturday morning, with 75 persons in attendance. The reports of officers were read and accepted, followed by interim reports of the work of the various committees.

The following slate was presented for membership, to the Council, to be elected at the annual meeting in October:

Mrs. W. M. Kearons, Fall River, Massachusetts
Mr. Claude B. Carpenter, Wayne, Michigan
Dr. Charles H. Smiley, Providence, Rhode Island
Miss Marjorie Williams, Northampton, Massachusetts.

Miss Williams was elected to fill out the unexpired term of the late Casper R. Gregory.

President Helen S. Hogg then called for the presentation of papers.

Reverend Paul A. McNally, S.J., Director of the Georgetown College Observatory, exhibited and explained the very excellent technicolor film of the National Geographic Society and Bureau of Standards solar eclipse expedition of October 1, 1940, taken at Patos, Brazil. This was followed by a very interesting account by Mrs. John A. Pierce of the Harvard-Cruft Laboratory expedition to Queenstown, South Africa, to observe radio phenomena in connection with the same solar eclipse.

Miss Ida M. Barney, of the Yale Observatory, discussed in detail the work incidental to the preparation of the Yale Photographic Catalogue of stars. The Recorder devoted some 10 or 15 minutes to the subject "Do Ordinary Novae Repeat?" He described the actions of the so-called SS Cygni and Z Camelopardalis-type stars—the Lesser Explosives—and their possible connection with the recurring novae, such as RS Ophiuchi and T Pyxidis, and what might be the chance that ordinary novae, such as Nova Herculis, 1934, and Nova Aquilae, 1918, would sometime have a second outburst—stars of the Major Explosive class. (See these notes in POPULAR ASTRONOMY for June 1941.)

Dr. William L. Holt of Tucson, Arizona, and Saco, Maine, presented a paper, read by Mr. Seely, on "A Stream-Lined Way to Observe Variables." He showed the advantages of a Springfield type of mounting, where one observes from a fixed position, with a correspondingly greater saving of time and lost effort.

Saturday afternoon was spent in a motorcade expedition to the Vanderbilt National Memorial Historic Site at Hyde Park, New York, where among many evidences of the display of art were two excellent orreries.

The climax of the meeting was, of course, the banquet held Saturday evening in the Alumnae House with about 85 persons in attendance. President Hogg turned the after-dinner part of the program over to Secretary Rosebrugh as toast-master, who, in between introductions, conducted a "quiz" dealing with the set of the Harvard Books on Astronomy soon to be issued.

The main speaker of the evening was Dr. E. S. Rademacher of the New Haven Amateurs whose address was on "The Relationship of Psychiatry and

Astronomy." That his masterly presentation of the subject was well received was evidenced by the close and keen attention paid by all. His address is worthy of repetition before still more august scientific and non-scientific bodies.

Dr. Alice H. Farnsworth took us, by means of slides made by herself and Dr. Smiley, over South America, and described her trip to observe the eclipse of last October and her subsequent travels in connection with her work on photographing the night-sky.

Following Dr. Smiley's presentation of resolutions expressing our appreciation to our hosts and all who had done so much to make the two-day event a genuine success, the meeting was adjourned to reassemble at Harvard on October 10 and 11, 1941.

Recent Catalogue of Cepheids: A catalogue of 281 Cepeids and a statistical discussion of the material collected in the catalogue is given in a recently published thesis by Walter Theile. In view of the rapidly growing knowledge about all classes of variable stars, together with the increasing interest in the theoretical investigation of stellar constitution, for which the Cepheid variables yield a most valuable contribution, such a compilation at the present time is very welcome. The catalogue contains the equatorial and galactic coördinates, proper motions, the elements of the light variation, the characteristics of the light curve, the photographic and visual range in brightness, and the spectrum. In the statistical discussion the results of earlier investigations are confirmed and somewhat improved with the greater amount of material which the writer had at his disposal. The 28 tables afford the means for special correlations existing for many quantities pertaining to the variables, such as period, amplitude, spectrum, luminosity, proper motion, parallax, and others.

Another Cluster-Type Variable with a Secondary Period: To the short list of exceedingly interesting cluster-type variables which have to date revealed secondary fluctuations in light curve as well as in period, can now be added Y Leonis Minoris, 101033, discovered by Ceraski in 1926 and recently the subject of discussion by D. Martinoff of the Engelhardt Observatory.

The period is $0^d.5224$, and the extreme limits of variation, as observed visually, are $11^M.6$ and $13^M.0$, with marked changes between maxima. In a cycle equal to 63.7 periods of light variation, or 33.4 days, the amplitude varies from $0^M.4$ to $1^M.4$. The maximum magnitude fluctuates between 11.58 and 12.47, while the minimum magnitude varies only between 12.82 and 13.00. Accordingly a greater change in range of light occurs at maximum than at minimum phase.

Three other stars with a similar periodic variation are known: RW Draconis, AR Herculis, and RR Lyrae. Facts concerning these and Y Leonis Minoris are given in the following table, which is self-explanatory.

Variable	Period d	Range — Maximum M M		Range — Minimum M M		Secondary Periodicity d	
RW Draconis	0.443	*10.49*	*11.22*	*11.94*	*12.40*	94	P = 41.64
AR Herculis	0.470	*10.30*	*10.81*	*11.67*	*12.06*	67	P = 31.5
Y Leonis Minoris	0.524	11.58	12.47	12.82	13.00	63.7	P = 33.4
RR Lyrae	0.567	6.95	7.32	7.82	8.06	67.41	P = 38.21

For a few other cluster-type variables similar variations in amplitude have been established, but as yet no satisfactory secondary period has been found. Literally hundreds of observations on many nights over long intervals of time are required to derive such secondary periods with the required degree of certainty.

Observers and Observations received during the months of May and June, 1941:

Name	May Var.	May Obs.	June Var.	June Obs.
Albrecht	8	8		
Ball, A. R.	7	7	32	45
Ball, J.	27	35	43	73
Bappu	26	65		
Blunck			30	37
Bouton	53	81	74	104
Brocchi	12	18		
Buckstaff	10	20	9	9
Cameron	16	21		
Cave	15	29	7	20
Chandra	153	261	122	257
Cilley	48	100		
Cousins			39	150
Dafter			9	22
Diedrich	4	6	28	37
Escalante	39	39		
Fernald	151	283	147	303
Ford			23	23
Franklin	22	35	15	24
Geise			3	3
Gillespie			15	16
Griffin	36	36	22	22
Halbach	117	152	38	53
Harris	25	25	24	24
Hart	7	15		
Hartmann	116	171	103	149
Hayner	3	3	3	3
Hiett	6	15		
Hildom	1	2	19	25
Holmes			3	3
Holt	143	344	137	249
Houghton	68	130	82	129
Houston	10	12		
Howarth	17	18	19	25
Jones	7	7		
Kearons	78	160	62	105
Kelly	11	15	15	18
de Kock			66	210
Koutz	49	80	104	190
Livingston	55	82	40	41
Lovinus	5	5		
Manlin			35	62
Martin	4	4		
Mason	17	17	5	5
Morey			8	8
Maupome	48	55		
Meek	15	27		
Millard	18	32		
Moore	5	5		
Nadeau			10	33
Parker	27	27	41	42
Parks	20	35	22	36
Peltier	100	204	91	153
Prinslow	3	3	9	9
Renk	6	6		
Rosebrugh	15	40	8	34
de Roy	10	50	6	23
Ryder	3	3		
Salanave	1	1		
Saxon	68	97	57	64
Schoenke	4	4	20	31
Shultz			15	15
Sill	26	26	10	10
Smart	19	63	63	110
Smith, F. P.	12	12	14	14
Stahr			10	13
Taulman	35	35		
Tomita			4	28
Topham	38	38	22	22
Toyek			2	2
Vohman	4	4	1	2
Walton	8	20		
Webb	12	12	35	40
Wilson			7	9
Yamasaki	36	36	27	31
Totals		3173		3065

July 11, 1941.

Notes from Amateurs

Yakima Amateur Astronomers, according to *The Observer*, official publication of the Yakima Amateur Astronomers of Yakima, Washington, the annual picnic of this group was held on Tuesday, July 15. In addition to the usual picnic features, several persons gave talks on astronomical topics. Mr. Orris Thomson is president of the club for this year.

The Ninth Year of the Rhode Island Skyscrapers

The annual election and business meeting of Skyscrapers, Inc., Amateur Astronomical Society of Rhode Island, was held at Ladd Observatory, Brown

University, on June 5, 1940. The following officers were elected: President, Samuel M. Holman, Jr.; Vice-Presidents, William J. Gardner, Miss Angeline M. Pettey; Secretary-Treasurer, Miss Grace D. Harris.

The program of the ninth year was as follows:

July 17, 1940. Outdoor meeting at the Skyscrapers' own observatory, The Seagrave Memorial Observatory, North Scituate, Rhode Island.

August 14, 1940. Meeting at Seagrave Memorial Observatory. Members and friends of Skyscrapers supplemented funds made available by Brown University to send two of our members, Dr. Charles H. Smiley, chairman of the Department of Astronomy at Brown University, and Arthur A. Hoag, student at Brown, to the interior of Brazil to photograph the total solar eclipse of October 1, 1940. Reports on the completion of the Schwarzschild astronomical camera were given by Dr. Smiley, J. Frank Morrissey, and Frederick W. Hoffman.

September 20, 1940. Outdoor meeting at Seagrave Memorial Observatory. A report of the Eclipse Expedition was read by Miss Mary H. Quirk.

October 23, 1940. In preparation for the transit of Mercury on Nov. 11, Mr. F. W. Hoffman spoke on "What, When, and How to observe during the Transit." Miss Angeline Pettey told of "Previous Transits," and Dr. Victor A. Goedicke lectured on "The Riddle of Mercury."

November 13, 1940. Dr. Charles H. Smiley lectured on "Brazilian Eclipse Experiences." Over 300 Kodachrome slides made on the expedition to Brazil were shown. Arthur A. Hoag spoke on "Boats," describing many used on the trip.

December 10, 1940. Dr. Richard Goldthwaite of the Geology Department of Brown University spoke on "Modern Weather Forecasting."

January 8, 1941. Members and friends of the organization saw mathematics, telescope, constellation, and variable star sections of the society in action at Ladd Observatory.

February 10, 1941. Dr. Arthur M. Harding, director of the Extension service at the University of Arkansas, spoke on "Glimpses of Other Worlds."

March 5, 1941. Three talks on the "Moon in Face, Fact, and Fancy" were presented. Mr. William J. Gardner discussed the "Face," illustrating his talk by means of a large model which he had made. Miss Mary H. Quirk spoke on "Lunar Facts," and Miss Jean Bonjour discussed "Moon Lore."

April 9, 1941. Motion pictures of the activities of the Skyscrapers were shown as well as a reel of "American Observatories."

May 7, 1941. The ninth annual dinner of the society was held at the Faculty Club, Brown University. Following the dinner, the members and guests of Skyscrapers heard Dr. Bart J. Bok, associate professor of Astronomy at Harvard College Observatory, speak on "The Truth about Astrology."

Open nights were held throughout the year for members and guests to look through the 8-inch Alvan Clark refractor at the Seagrave Observatory. On January 1, 1941, when the general public was invited to observe comet Cunningham, approximately 800 persons attempted to gain admission. A large number of these were able to view the comet before it set.

Telescope making, variable star observing, and the computing of orbits have been occupying the time of the members of the various sections of the society. Various orbits and ephemerides for comets were published during the year.

The Skyscrapers have just purchased additional land at the Seagrave Observ-

atory. This purchase was made possible by a sum of money willed to the society by Miss Victoria E. Atwell, a loyal member.

June 7, 1941. GRACE D. HARRIS, *Secretary*

General Notes

Soon after the appearance of this issue, the Editor will begin a leave of absence which will continue through the first half of the academic year 1941-42. During this time he will make a journey through the West and Southwest which will have astronomical observatories as the principal points of interest.

In his absence, the details of the publication of POPULAR ASTRONOMY will be in the hands of the several members of the staff of Goodsell Observatory: Professor E. A. Fath, Director, Dr. R. S. Zug, Instructor, and Olive M. Hawver, Secretary.

Mrs. Cecilia Payne Gaposchkin, astronomer at the Harvard College Observatory, received on May 10 the degree of doctor of science at the seventy-first annual commencement exercises of Wilson College, Chambersburg, Pa. (*Science,* June 13, 1941)

Dr. Arthur M. Harding will become the president of the University of Arkansas on July 1. An educator and mathematician whose hobby is popular astronomy, Dr. Harding's book "Splendor of the Heavens" has been a best-seller in the field.

Professor Frederick Slocum, director of the Van Vleck Observatory and for twenty-five years a member of the faculty of Wesleyan University, has been appointed professor emeritus, effective at the close of the college year. He will continue to direct the observatory and to teach two courses during the coming academic year. (*Science,* June 13, 1941)

The Rittenhouse Astronomical Society of Philadelphia held its regular monthly meeting on June 25 as an outdoor meeting. The place was on the steps of Memorial Hall in Fairmont Park and the time was spent in studying the constellations.

The McDonald Observatory, Fort Davis Texas, now jointly used and administered by the University of Texas and the University of Chicago, will, according to newspaper accounts of July 14, afford opportunity for astronomical research to a third institution. The unusual facilities of the observatory have been allotted to workers from Indiana University for fifteen nights each year. Professor Frank K. Edmondson, director of this new research, states that the program for the present will be devoted to a study of star motions.

American Astronomical Society Meeting

Upon the invitation of Director Otto Struve, the sixty-sixth meeting of the American Astronomical Society will be held at the Yerkes Observatory, Williams Bay, Wisconsin, September 7-9, 1941. The meeting will be followed by a symposium on Astronomical Spectra under the auspices of the Yerkes Observatory, as part of the semi-centennial celebration of the University of Chicago.

Mathematical Association of America

The twenty-fourth summer meeting of the Mathematical Association of America will be held at the University of Chicago, Chicago, Illinois, on Monday to Thursday, September 1-4, 1941, in conjunction with the summer meeting and colloquium of the American Mathematical Society and the meetings of the Institute of Mathematical Statistics and the Econometric Society. At the time of the meetings the University of Chicago will be celebrating the fiftieth anniversary of its founding, the theme of which has been designated by the University as "New Frontiers in Education and Research." As an important part of its anniversary celebration the University of Chicago has collaborated with the Association and the Society in arranging a special program which it is hoped will give these meetings an unusual significance for future mathematical education and research.

Midwest Group Meeting

Astronomers of the midwest held their last meeting of the season at the Washburn Observatory, Madison, Wisconsin, on May 31. Several problems concerning the solar system were discussed. P. Swings described recent observations of the spectrum of Comet Cunningham—in which new bands of NH, OH, and CH were found in the ultraviolet. Interesting features of the rotational structure of the CN bands indicate the low temperatures of the material from which the coma is formed. N. T. Bobrovnikoff described the progress of his investigations of the law of variation of cometary brightness. Comets show unexpected sudden changes of brightness, as well as changes of the manner in which the brightness varies with distance from the sun. The rate of loss of cometary material is very slow. C. C. Wylie discussed the technique of obtaining reliable reports on bright meteors from the public, and the psychological errors involved in the judgment of meteor velocities. Reviewing the most reliable cases, he showed that most bright meteors are members of the solar system, moving in elliptical orbits of moderate eccentricity and inclination. Finally, W. J. Luyten reviewed the scientifically plausible theories of the origin of the solar system, and pointed out fundamental dynamical and physical fallacies in those which postulate a catastrophic origin. While no complete theory has yet been proposed, it seems probable that an "internal" theory must be sought, *i.e.*, one in which the solar system would be the result of some relatively common and regular process.

JESSE L. GREENSTEIN, *Secretary*

Observation of the Solar Eclipse of March 27, 1941

I observed this eclipse at Sao Paulo, Brazil. The first contact was visible at $17^h\,30^m\,41\overset{s}{.}5$ ($\pm$ 3 s) in Standard Time of Rio de Janeiro, which is three hours west of Greenwich. At sunset, $18^h\,04^m$, the moon covered 1/5 of the sun.

Sao Paulo, Brazil, Rua Theodoro Sampaio 1120. HERBERT LUFT

Teachers of Astronomy

A meeting of Teachers of Astronomy will be held at the Yerkes Observatory on Sunday, September 7, at 2:30 P.M. There will be an exhibit of astronomical texts, elementary and advanced, popular books on astronomy, periodicals, laboratory notes and equipment, diagrams, charts and lantern slides.

Those who wish to exhibit material should send same to Yerkes Observatory, Williams Bay, Wisconsin, in care of Dr. Jesse Greenstein. Any questions concern-

ing possible exhibits should be addressed to the above or to John H. Pitman, Swarthmore College, Swarthmore, Pa.

Color of the Lunar Surface

My collaborators and I have completed a long series of visual observations of the general color of the surface of the moon using the 6-inch telescope of the Second Astronomical Observatory at Odessa (U.S.S.R.). This telescope is equipped with magnification powers from 3000× to 10000×. Our estimates are given in the accompanying table:

No.	Date 1940	U.T. h m	Estimate	Observer
1	Feb. 25	22 30	Deep tawny yellow	Leonid Andrenko
2	Mar. 11	20 30	Dark yellow	E. Malakhov
3	Mar. 18	20 30	Deep dark gray	Mrs. L. Andrenko
4	Apr. 16	20 30	Deep tawny gray	Miss V. Ephremova
5	Apr. 17	20 30	Deep fallow	Occasional visitor
6	Apr. 23	20 30	Yellowish fallow	Occasional visitor
7	Sept. 23	21 30	Chocolate	Miss A. Yuvilevitch
8	Oct. 25	20 30	Fallow	Miss S. Kalmanovitch
9	Oct. 25	20 35	Fallow	Miss M. Dumanska
10	Nov. 28	20 30	Fallow gray	P. Patzay

It is seen that the estimates, made entirely independently, are sufficiently homogeneous to show that the general color of the moon is a deep tawny yellow which corresponds exactly to its small albedo, 0.07.

Leonid Andrenko.
Second Astronomical Observatory, Odessa, (U.S.S.R.)

Line of Planets

By L. J. Comrie, Ph.D., and S. M. Burrough, B.Sc.

In a note under the above title in last year's *Journal*, page 31, Mr. T. H. L. Hony draws attention to the fact that the Sun and seven planets, Mercury to Neptune, were in increasing order of right ascension during part of November, 1939. His concluding remark that "such a configuration will not occur again *for a very long time*" has led us to investigate whether this sequence does occur again during this century.

We first examined the four outer planets, Jupiter, Saturn, Uranus, and Neptune, since if these four are not in the correct sequence it is obviously useless to attempt fitting the Sun, Mercury, Venus, and Mars into the scheme. They were found to be in order between 1959 and 1961, but the arc between Neptune and Jupiter was insufficient for the other planets. The only other time when the correct sequence of the outer planets holds is between about 1975 and 1981; this period was examined in greater detail.

The geocentric longitudes of the planets were computed with the aid of Schoch's *Planeten-Tafeln für Jedermann* and plotted against time. Jupiter passes Saturn about August, 1981, and so this date formed the upper time limit in our calculation for Mars, etc. At this date the difference in longitude between Jupiter and Neptune is about 80°, leaving an arc of 280° for the Sun and inner planets. Mars was then computed, and when its longitudes and those of the Sun were plotted the possible times for the occurrence of the grand sequence were greatly reduced. A very short period at the end of 1978 in which the Sun had not passed Mars gave no opportunity for Mercury and Venus to come between the two. The

other remaining period was from December, 1980, to April, 1981. A calculation of the longitude of Venus showed that it preceded the Sun over the whole of this period, thus removing the last chance of a repetition of the sequence during the twentieth century.

(*Journal of the British Astronomical Association,* June, 1941)

Correction: In the June, 1941, issue, page 339, line 21 from bottom, insert a minus sign immediately after the sign of equality; page 341, line 15 from top, for *conditions* read *condition.*

Book Reviews

Other Men's Lives, by Sir George Dunbar. (The Scientific Book Club. London, W.C. 2).

This volume is only slightly or, possibly, not at all related to astronomy. However, it was sent for the purpose of a review and we make mention of it for that reason.

It is concerned with prehistoric man and with those remaining groups which still retain the customs and methods of life which apparently prevailed in prehistoric times. The long periods of man as a hunter and later as a farmer are traced. Three groups in which traces of very early habits of the human race are recognizable are discussed. First, the Tasmanians who have recently practically disappeared; second, the North American Indians who are fast becoming absorbed by western civilization; third, those living in remote regions of Asia on the Tibetan border.

One concerned with archaeological, ethnological, or anthropological questions will find interest in this volume.

We who are so dependent upon the modern aids for comfortable living, or even, it seems, for mere existence, wonder at the persistence of primitive peoples who continue their unchanged methods of life century after century.

C.H.G.

Three Copernican Treatises, translated with introduction and notes by Edward Rosen. (Columbia University Press, New York City. $3.00.)

The three treatises included in this volume are: 1. The Commentariolus of Copernicus; 2. The Letter against Werner; 3. The Narratio prima of Rheticus. The volume is the thirty-third in the series of Records of Civilization, being issued under the auspices of the Department of History of Columbia University. In the announcement of the volume it is stated that this volume makes available, for the first time in English, the three treatises which comprised the only written warning the sixteenth century had of the coming work of Copernicus which was to upset a self-centered theological world by propounding a heliocentric theory of the universe. This being the case, it fills an important place in the English literature of the history of astronomical development.

There is a helpful and illuminating introduction of fifty-three pages by the translator, and numerous footnotes and references are found throughout the book. Finally the volume is well indexed, thus making reference to a particular topic quick and easy.

The volume deserves a place in every historical library as well as in every natural science library. C.H.G.

The Internal Constitution of the Stars, is the title of Article 1, seventy-six pages of Volume 41 of the Annals of the New York Academy of Sciences. This article is published separately and contains papers by the following titles and authors:

1. Introduction to the Conference on The Internal Constitution of the Stars, Harlow Shapley.
2. The Distribution of Density within the Stars, Henry Norris Russell.
3. The Ellipticity and Reflection Effects in Eclipsing Binary Systems, Zdeněk Kopal.
4. The Radiative and Conductive Opacities Under White Dwarf Conditions, Robert E. Marshak.
5. On Stellar Envelopes, Jaakko Tuominen.

These papers were presented at a conference under the auspices of the New York Academy of Sciences on October 20 and 21, 1939. The names of the writers of the papers are a sufficient indication of the dependability and importance of this series in the field discussed. The pamphlet was published and issued by the Academy. C.H.G.

The Restless Earth, by R. Gheyselinck, (The Scientific Book Club, 111 Charing Cross Road, London, W. C. 2. 2/6 to members.)

This volume was published in 1939, hence this review is somewhat belated. Originally written in Dutch it was translated into German and in turn translated from the German into English by Dr. Ernest Fellner and Betty Inskip.

It consists of 285 pages divided into seven chapters as follows: The Enigmatic Beginning; The Face of the Earth; Petrified Life; The Great Rhythm; Mountains Grow; The Unsteady Crust; Wegener. There are seven full-page illustrations of features discussed in the text.

The title of the volume is one to arrest the attention. To the naive mind or to one which has not considered the questions critically, the title seems to contain a contradiction. Obviously rivers are flowing and ocean waves are rolling, but the coastline and the mountain ranges assuredly remain at rest. A reading of this volume will correct this erroneous impression. To be sure the changes in the apparently unchanging features of the surface of the earth in the span of a human life-time are practically unnoticeable and negligible. It is only in the almost inconceivably long intervals of time involved that these changes become significant. The fact that the beginnings of the earth are lost in the dark and exceedingly remote past once being recognized and appreciated, the appearance and disappearance of mountain ranges, the emergence and the submergence of continents become mere incidents in the numerous changes.

The book, clearly and interestingly written, will enlarge the reader's horizon and will enable him to see the picture presented in its larger aspects, instead of being lost in its insignificant details. C.H.G.

The Man in the Moone and Nuncius Inanimatus

These two rather classic papers by the early English writer, Bishop Francis Godwin, appeared in *Smith College Studies in Modern Languages,* Volume XIX, No. 1, edited with introduction and notes from unique copies of the first editions

of London, 1629, and London, 1638, by Grant McColley, research consultant. Because of the close relation between the imaginary situation depicted in these accounts and actual happenings at present, these papers furnish exceedingly interesting reading today. In the first a trip to the moon and subsequent return to the earth are actually accomplished through the mere device of the flight of migratory birds thus perhaps predicting the extensive airplane activity of today. In the second the telephone, or possibly even radio, is dimly suggested. These papers, therefore, may be recommended for stimulating reading to the present generation more than three centuries after they were first written.

Publications of the Astronomical Observatory, University of Minnesota

Four brochures of these *Publications* have recently been received. They are related to results emerging from the Bruce Proper Motion Survey.

The titles of the several parts are:

Vol. II, Number 10—The Stream Motions of 92,656 Stars.

Vol. III, Number 1—A Catalogue of 904 Stars in the Southern Hemisphere with Proper Motions exceeding 0".5 annually.

Vol. III, Number 2—Catalogue of 696 Stars with Proper Motions between 0".3 and 0".5 annually South of Declination —50°.

Vol. III, Number 3—Catalogue of 832 Double Stars with Common Proper Motion in the Southern Hemisphere.

IRREDUCIBLE MINIMUM

Wonder of wonders, here am I,
Sentient to earth and sea and star:
Orion, striding up the sky
In belted light, is less by far
Than I who think and dream and will:
But who am I, and where? Or you?
Worlds be quiet: stars be still.

I seek the beautiful, the true,
And full intend to serve the good:
But what is good? Surely to live,
To feel, to be well understood
By someone whom I love, to give
Nothing shabbier than my best
To you, my neighbor, standing here
With me in space and time, a guest
Upon this forward-whirling sphere.
Where are we going together, friend?
What are we doing here?
We *are*,
But who are we? To what far end
Does living lead? To what high star?
We came like air, we go like snow
Before the autocratic sun,
And guess, although we cannot know,
That earth and stars and men are one.

—Harry Elmore Hurd.

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